INSPIRATION

Enriched, updated and prioritised overview of the transnational shared state-of-the-art as input for WP4 to develop the SRA

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Methodological background

Fig. 1 shows the workflow of WP3 between March and October 2016 including desk study, transnational multi-stakeholder workshops forming the transnational commons towards WP4. Find details in the subchapters below.

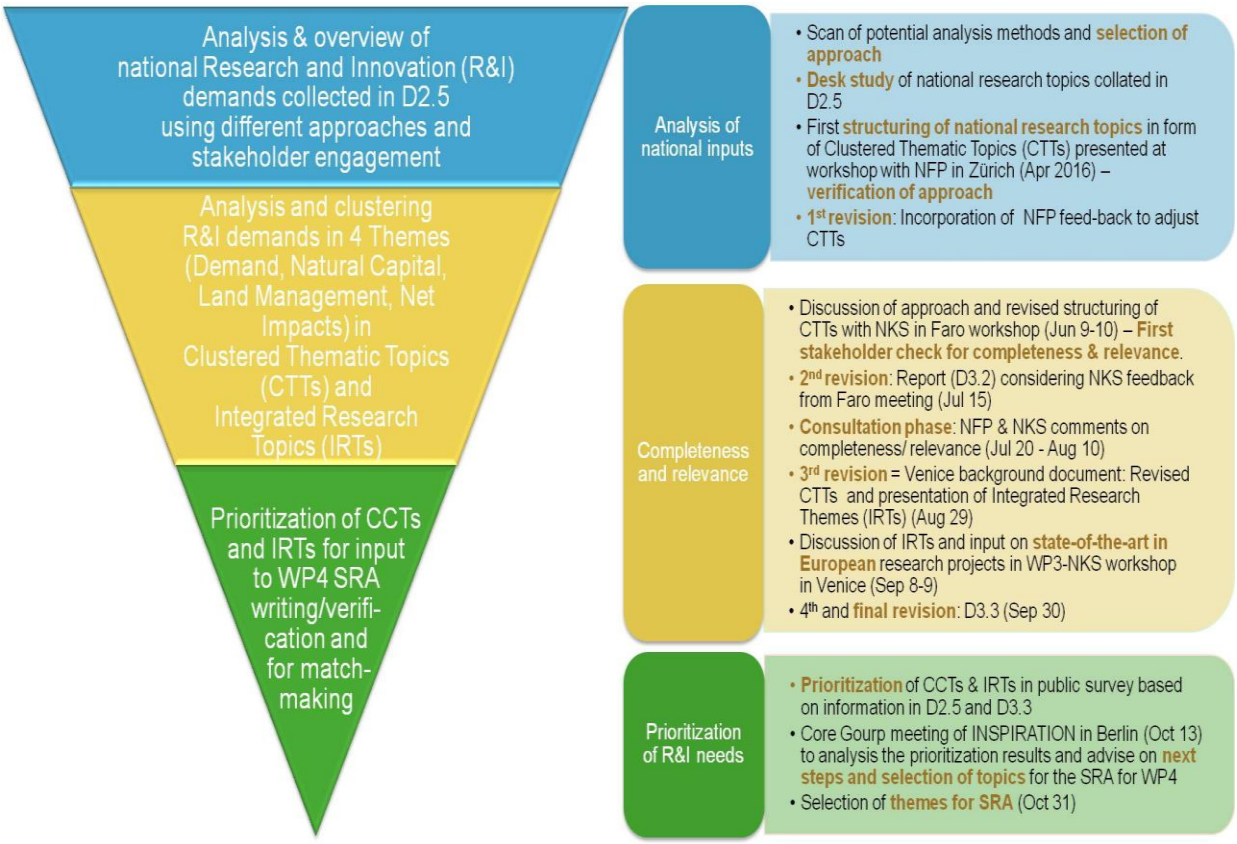

Fig. 1: Overview of workflow and summary of steps of WP3

Identification Clustered Thematic Topics and Integrated Research Topic

This approach attempts collating the demands in clusters linked to the conceptual model, i.e. aggregated under 4 themes as well as across them.

Box 1: Conceptual model of INSPIRATION

Sustainable land management seeks to balance the demand and supply of resources and our natural capital, to cope with the effects of several driving forces putting pressure on the system and to decrease the global footprint of human made production and consumption activities. Thereby the main EU societal challenges, which are expressed in the Horizon 2020 work programmes, will be addressed. In order to identify cross-country and cross-sectoral knowledge gaps, research questions are structured along four overarching perspectives within INSPIRATION's conceptual model:

Land and the SSW-system are goods and natural capital stocks that have to be used in a way that maximises the non-depleting use of ecosystem services. However, there are manifold drivers which affect natural resources, their potentials as well as their use, and which may eventually lead to a degradation of whole ecosystems. Intensive and unsustainable land use may have significant impacts to ecosystems and their ecological functions. Additionally, ecosystems are affected by natural drivers like extreme climate events in particular due to climate change (flooding, dry period, etc.).

Box 1: Conceptual model of INSPIRATION - continued

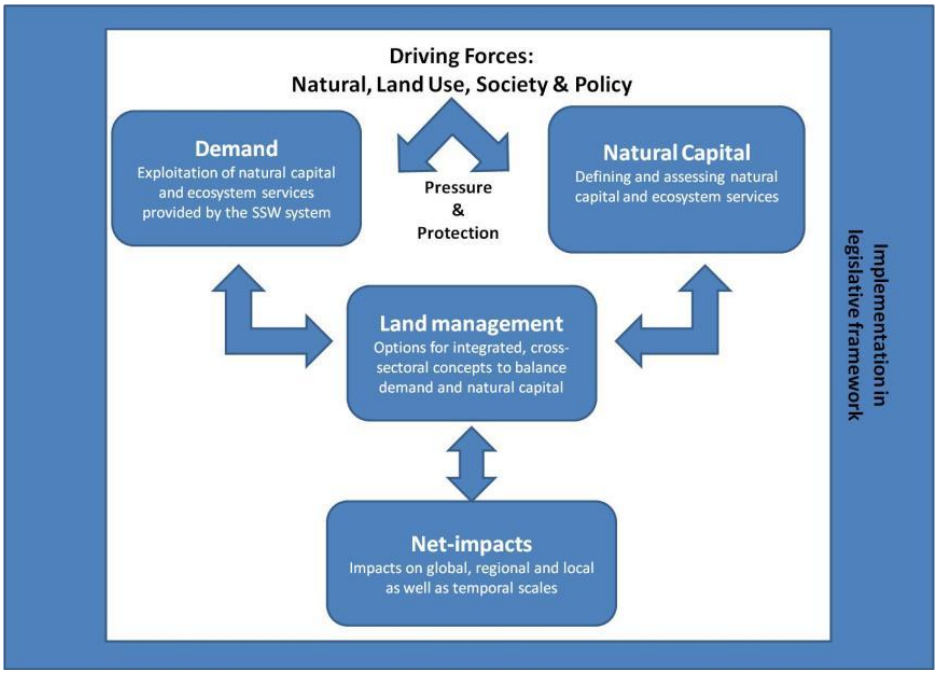

Fig. Box 1.: INSPIRATION's conceptual model

Principally, there are conflicting interests regarding land use among many relevant stakeholders in society, such as farmers, land planners, developers, industry, citizens. As a rule, both are following mainstreams of a paradigm of 'Either-Or': expectations of land-users towards maximizing economic benefits on the one hand, and maximum requirements from environmentalists towards protective regulations on the other. Thus the sustainable management of agricultural, forest and urban land resources as well as the conservation of biological diversity or natural capital has to follow integrated, cross-sectoral concepts in order to address the different demands of all stakeholders. Moreover, the economic, societal, administrative and political impacts, which are steering and governing land use in the broad sense have to be considered. Thus the net-impacts on a local, regional and global as well as temporal scale are significant back-coupling drivers and determinants of crucial importance.

These challenges must be tackled to benefit from the land and the soil-sediment-water system and to avoid depletion of our natural capital and resources. Better land use and land management are the means to that end. Multi-dimensional and intra-disciplinary approaches to research have been very successful in building our present understanding of ecosystems with their services and to protect natural resources. The challenges we face inherently straddle disciplinary boundaries and changes in one domain can have unwelcome and unforeseen consequences in another.

First, a spread sheet approach is used to structure the diverse national research topics, where the Theme Leaders first prioritise the national research topics according to their perceived major, minor or not given relevance for the specific theme. It can augment the systematic text analysis and the identification of overall research topics by looking at the national report from a theme-wise perspective, thereby interpreting results of WP2 in the light of INSPIRATION's conceptual model. Research collated under these four theme perspectives were to be clustered across the INSPIRATION countries in so-called "Clustered Thematic Topics (CCTs)" within each of the four themes, which are representing perspectives under which to analyse the national research needs collated in D2.5. These themes aim to cluster research gaps regarding sustainable land management stewardship along four questions targeted at revealing the strategic research demands. For each area, a Theme Leader is taking the responsibility for the execution of the evaluation and synthesis.

Box 2: The 4 INSPIRATION Clustered Themes

***Demand**: What does society demand from natural capital and ecosystem services including the SSW-system? – Theme Leader: J. Villeneuve BRGM*

***Natural capital**: What has nature, including the SSW-system to offer and which determinants sustain the system? – J. Zeyer ETH*

***Land management**: What are options for an integrated, cross-sectoral land management to balance societal demands and natural capital? – J. Gorgon IETU*

***Net impacts**: What are the impacts of different options of managing natural capital, including the SSW-system on global, regional and local as well as temporal scales? – C. Schröter-Schlaack UFZ*

In a final step, to address and collate the cross-country topics that also crossing and bridging the four themes, "Integrated Research Topics (IRTs)" are identified.

The advantage of this approach is that it allows identifying cross-national and cross-sectoral research priorities in each of the themes of the conceptual model – and in the last step across them. It helps overcoming the risk of developing sectorally isolated research priorities, e.g. for agriculture, river management or soil science, while it seems imperative to acknowledge the interplay of these activities and of different disciplines in gauging a better understanding for future research needs. A certain disadvantage but also chance, however, is that this approach could require more efforts in communicating the conceptual model and the content of each theme to be comprehensible to NKS / NFPs.

Figure 2 illustrates on the left the collation of national research topic under the four themes of the conceptual model. On the right, the identification of "Clustered Thematic Topics (CCTs)" and "Integrated Research Topics (IRTs)" is illustrated.

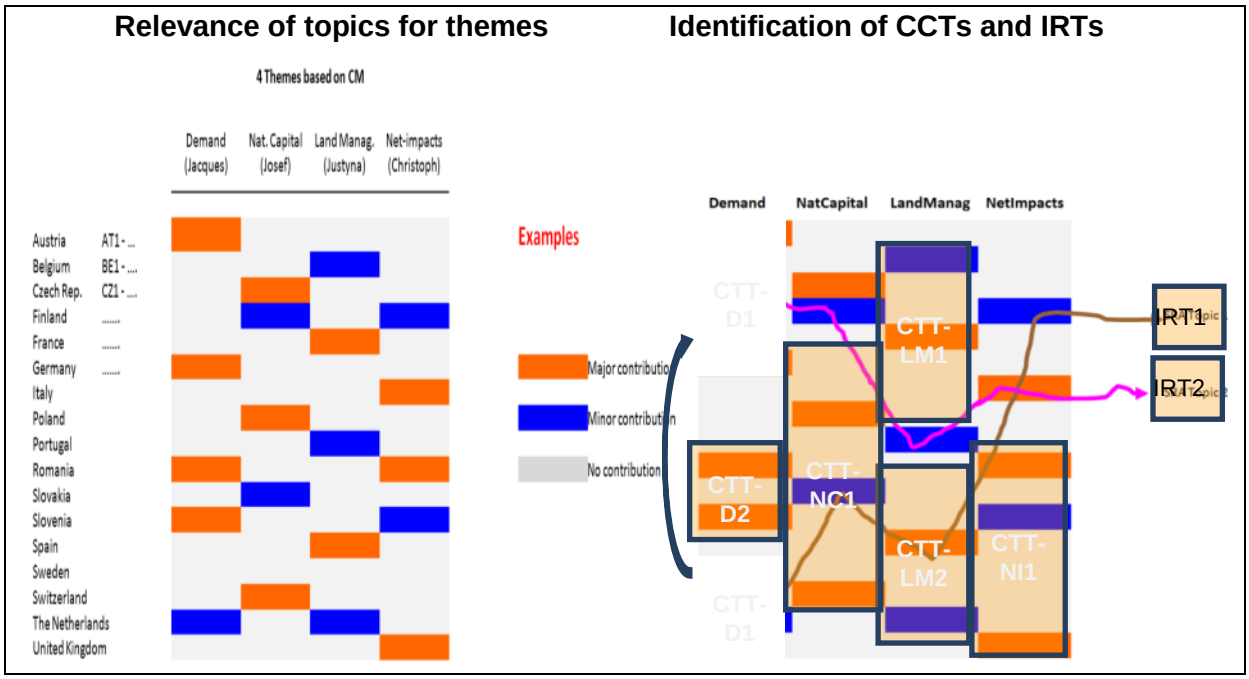

Fig. 2: Approach to assessing research topic relevance for aggregated themes (left) and for identifying Clustered Thematic Topics (CTTs) and Integrated Research Topics (IRTs) (right).

Transnational R&I needs

Demand

The theme Demand focuses on the thematic approach of research and innovation needs concerning the “demand” for the SSW system services. The research questions expressed in the national reports (D 2.5) are structured in seven clustered thematic topics (CTT). The first aim is to understand the links between consumption and the use of the SSW system services: the need is to quantify and map in time and space the systemic aspects of the nexus of SSW resources used for the final consumption of goods and services. A second issue is to adapt the consumption to mitigate the demand for the SSW system services: the need is to find more “resource-efficient” ways of consumption linked the direct demand of bio-sourced goods and area for the built environment and to save resources. And finally, to quantify and assess the indirect demand of SSW system services: how to assess the (long term) demand for ecosystems services used to preserve/improve the quality of life, the health.

CTT-D1: The 4 F´s: Food, feed, fibre, (bio)fuel

Soils are as production site the primary geo-resource for production of biomass and a key element in the bioeconomy (the so-called four F´s). Biomass is used for production of agricultural goods for direct consumption or for conversion to diverse food products or chemical raw-material (like oils), for feed in animal husbandry, for various fibres and play especially with organic renewable in energy production as non-fossil fuels a growing role.

On the other hand, soils as production sites for biomass are increasingly threatened by land and soil consumption for infrastructure and because of land degradation, so the availability of fertile soils is shrinking, while demand for the 4 F’s is growing. Furthermore, consumption behaviour towards higher meat diets and luxury food together with climate change and adaptation challenge soils and their role for water production and functional biodiversity. While soil assessment traditionally concentrates on biomass production, the provision of environmental services have to be taken into account and evaluated since they are increasingly demanded by society to contribute to human life and environmental quality such as flood protection areas or nature conservation (see CTT 4 and CTT 7).

Use of degraded soils for non-food purposes may be an option as a remediation method too and may avoid a conflict with food security. Remediation of degraded soils may also help in carbon management (sequestration) or improvement of local economy.

Integrated land assessment, land management and land use planning need reliable, actual and easily accessible data of land use, soil quality, and data knowledge. Basis for that is an integrated knowledge and management of data availability and security.

CTT-D2: Regulating Ecosystem services

The topic of soil, sediment and water ecosystem functions includes research needs related to regulating and maintenance services. These are changes and interactions of biogeochemical cycles, soil carbon dynamics and climate change impacts on it, balancing bio-economic pressures with needs to adapt to climate change and protect biodiversity in

forests and mires, identification of soil-related preconditions for sustainable intensification of food production, and assessment and mapping of soil ecosystem services.

Sustainability and sustainable management of natural resources require an optimization of soil functions including approaches, methods and instruments of the productive land against its transformation towards build-up areas. Other demands are intensive and ecologic acceptable productions in agricultural and forest country, the effect of land management due to ownership changes, and the harmonization of methods and structure of data.

Research needs are related to soil functions and services in general, the development of a specific methodology of evaluation of the demand and supply of soil functions and services associated to urban, industrial, natural and production (agricultural and forest) ecosystems. Challenges are also on an integrated modelling in order to optimize the management of the landscapes in link with the agro-ecosystems. Special attention in different regions has to be given to re-valorisation of degraded sites according to their future urban, suburban or rural use (see for example the “Evaluation of expenditure and jobs for addressing soil contamination in Member States” at http://ec.europa.eu/environment/soil/pdf/Soil_contamination_expenditure_jobs.pdf) . Attention has to be given also on potentials and dynamics of carbon sink and sequestration potential and GHG balance dependent from sites and land use.

The restoration of soils is a way to improve ecological services also why soil contamination affects ecological services detrimentally. Even if sometimes ESS services may be facilitated by contamination (e.g. interesting biodiversity).

CTT-D3: Urban / infrastructure land

The demand on land for settlement areas, surface as well as subsurface infrastructure, as well as other uses such as landfill sites is constantly increasing. Land use in itself is in constant transition according to the needs of stakeholders (residential areas, industry, mobility/transports, recreation areas, housings,…). Urban expansion, population density and type of land use of the different regions - all affect the social, economic and environmental quality of cities and regions and have effects on the soil and city climate. The high demand leads to conflicting goals in regards to the use of land, for example, for settlement and infrastructure as well as green infrastructure in urban areas. Expanding areas with specific land uses are faced with the task of mobilizing land potentials despite the presence of a high level of competition for use. On the other hand, stagnant or shrinking regions have a surplus of land potentials which require concepts for deconstruction and the re-naturalisation of land. Brownfield remediation and recycling for urban use play a major role in saving soils for other purposes.

CTT-D4: Water

Clean and sufficient water is a key element for a healthy functioning SSW-system, the production of biomass, the provision of clean drinking water and groundwater sustainability. It is also a driving force for landslides and floods within the SSW-System (see CTT-.6) Special attention should be given to water resources affected by agricultural land use i.e. high density of livestock breeding, agriculture, irrigation, transfer of agricultural land to settlements and ongoing climate change.

The EU will increase the reuse of treated waste water to fight water scarcity (http://ec.europa.eu/environment/water/reuse.htm). Open questions are the contaminants in the water and the treatment for cleaning. This is also a major question for intact soil functions (filtering and buffer functions).

Within the landscape context key questions on water research are needed for assessment methods for spatial water potentials for agriculture in the context of different land use intensities and changes as well as water balance in meso-catchments. Other needs exists on (existing and) emerging pollutants for (drinking) water from surface and groundwater, for retention potentials for water in micro- and meso-catchment and reducing natural hazards, the quality and quantity of surface and groundwater, knowledge on water resources fluctuations within seasonal fluctuations and the demand from different sectors like agriculture, industry and homes. Finally manageable models have to be elaborated not only for waters users itself, but also for planners and politicians.

CTT-D5: Geological (and fossil) subsurface resources

Geological subsurface resources like peat, gravel, sand, lignite and other materials are needed for economic development. The shallow extraction of resources (peat and brown coal more in the past, currently still sand, clay and gravel) influence landscapes strongly. Extractions (shallow and deep extraction such as salt) also leave space that can be reused or re-developed. Resource extractions highly influence the soil-sediment-water system and its ability to deliver ecosystem services.

Depletion of many non-renewable natural resources, such as minerals and nutrients, is an increasing problem. Sand and gravel has been used for decades in the construction of buildings and infrastructure. Some resources, such as gravel and good quality building material, have become scarce close to their consumption in cities and have to be transported considerable distances. Promoting the recycling of materials and alternative materials (biomass) can help to guarantee their availability and decrease environmental impacts, but methodology and procedures need to be further developed. As extraction activities are often only temporary, the re-use of land areas is an important issue and can provide new opportunities. Special attention should be given to re-use, re-built, and recycling to come not only to a circular economy but find examples for up-scaling of wasted materials.

Peat is known as a big source of energy and is also used in agriculture and horticulture. But peat is also a sink for CO_2 and thus a form of climate mitigation. When used it is a source of CO_2 and contributing to climate change. That is why alternative for peat have to be found and establish.

Lignite resources are great especially in the North of Europe but for instance Germany will bail out from the lignite mining. Because of remediation needs in shorter timer and on greater scale (mostly used as open pit mines) there will be a higher need development of effective remediation techniques than before.

Stones, gravel and sand are the most needed materials in the building industry. As far as we have activities in infrastructure development the materials are urgent needed. In some countries new sites to mine gravel and sand have to be developed because the known deposits are either depleted or blocked by conflicting uses.

On the other hand the underground itself is an important resource e.g. for Aquifer thermal energy storage (ATES) and geothermal energy. The relative amount of geothermal energy will develop from 2.2 to 13 per cent from 2010 to 2050 in Europe and the potential is referred to 300 TWh/y for Germany only. In the geological underground, instruments to weigh up underground land-use claims are missing with special attention to geothermal energy, fracking and building activities. Traditional uses of the underground like mining of fossil fuels and minerals and ore mining have to take into account their impacts to the SSW-Complex as well. Therefore a competition in land use is remarkable between the different use of land and soil.

CTT-D6: Areas where Natural hazards are prevented

Due to the anthropogenic changes in the world – building up an efficient infrastructure for the economy – the risk for and vulnerability to natural hazards and disaster have increased. Firstly changes in nature (river straightening, deforestation and agricultural monoculture, non-proper land use, unconscious water management) cause land and soil instability. Secondly climate change increases this instability, especially in some sensitive areas in Europe like the Alps or in Southern Europe. River straightening and soil sealing increase the risk of floods.

Landslides occur in many different geological and environmental settings across Europe. For example, large rockfalls, rockslides, rock avalanches, mud slides and debris flows dominate in the Alps and steep slopes in other mountain ranges, but also in coastal areas of Great Britain, Bulgaria, Slovenia, Italy, France and others. Soil subsidence in lower countries and delta areas cause water problems in case of severe rains.

Approaches, methods and instruments of the lowering and elimination of natural hazards and risks incl. risk assessment on land use/soil use are needed. Examples for natural hazards are: floods, forest disasters, forest fires, geodynamic hazards and erosion. Risk assessment is necessary in relation the quality of water, in effects of drought and floods following climate change and anthropogenic changes in the landscape. Mitigation measures to lower abiotic and biotic damages on forest and agriculture have to be developed.

Societal awareness of the research on the protection of particular natural resources is low. There are available knowledge, methodologies and models focused on efficient and sustainable use of nature, natural resources, land-use, modelling the natural risks and hazards, scenario building, but their usability in the practice is low. Therefore stakeholders and the civil society should be more involved.

CTT-D7: Health and quality of life (living environment)

Environmental quality, standard of life and wellbeing are essential factors for healthy living. They need attention, especially in deprived urban areas as well as in rural areas characterized by intensive agricultural land use. Research and practice often focusses on single environmental mediums and the related sectoral political field or expert planning discipline. It concerns landscape planning, soil, groundwater and sediment contamination, emission protection, transportation, and noise protection; also the connection with the stakeholders.

There is a need for an integrated approach when dealing with the living environment. This requires data, indicators and related tools for analysis which are integrative, practical and able to be communicated to the public and can be used in spatial planning processes. It is in this context that holistic instruments for the development of a healthy (smart) city should be created and tested through their use in demonstration activities.

Similar to cities there is a need for a healthy rural area affected by industry from urban areas (emission of dust, noise) but also by own emission e.g. from agriculture or industry moved out of the cities into rural areas. This is often the case in densely populated regions.

Natural Capital

Based on a careful study of “D2.5, National reports with a review and synthe-sis of the collated information” (Jos Brils et al.) it was decided to highlight 10 CTT as being important within the theme “natural capital”. This selection strictly relied on a bottom up approach and it was extensively discussed with the NFP at the workshop in Zürich (April 28-29, 2016). The overall concept was approved but the NFP suggested to add another CTT, namely “Geological ressources”. At the workshop the NFP’s also suggested to expand on the CTT “Intrinsic values of soils and landscapes”. All these suggestions were considered and the modified version of the text was discussed with the NKS’s at the workshop in Faro (June 8-11, 2016). The feedback by the NKS’s included the following major points:

- Quantity of soils, quality of soils, health of soils, carbon and green house gases are highly linked issues and should not be listed as independent CTT but merged into one CTT. This suggestion was considered in the present version of the text.
- Water is of paramount importance for all soil functions and this should be stressed in the text. This was now done all the way through.
- It will be a major challenge to quantify and monetize ecosystem services. A qualitative description of these services alone is a poor basis for soil management decisions. This suggestion was taken up and the Stern review is now mentioned as an illustration.
- There are a number of categorization concepts for ecosystem services and the NKS suggested to be mentioned in the text. This was done and for illustrative purposes the categorization used by the UNEP is shown in this version of the text.
- Several NKS stressed that soil management decisions are often very challenging because there is a legal conflict between private goods (e.g. land property, agricultural crops, real estate) and social goods (e.g. water quality, air quality, biodiversity).
- Last but not least a number of NKS mentioned that a splitting of the theme natural capital into CTT is inevitable but eventually somewhat artificial. Management decisions have to adopt an integrated view of all services.

In summary, after the workshop in Faro the text was modified and the theme natural capital now includes a total of 7 major CTT (see Figure NC-3)

CTT-NC1: Quantity and quality of soils, health of soils, soil carbon, greenhouse gases

Soil quantity (in terms of m^2) is an essential factor in agriculture and forestry as well as in housing and infrastructure. Scarcity of land with an adequate geotechnical quality triggers land use conflicts. Sustainable land use concepts are of paramount importance. However, for agriculture and forestry not only soil quantity but also soil quality is a crucial factor. A fertile unspoiled soil provides important structures (e.g. habitat for organisms) and functions (e.g. ability to catalyse biogeochemical cycles). A network of factors (e.g. compaction, exploitation, fertilization, etc.) can reduce fertility and the soil functions. The assessment of "soil health" is rather challenging. Soil carbon is a key factor for a fertile soil. Soil carbon has to be preserved.

Soils and particularly soil carbon play an important role in the cycling of greenhouse gases (GHG). Soils can produce or consume GHG. A few examples: Carbon sequestration by forests, selected crops or in wetlands is a major mitigation strategy for carbon dioxide. Over-fertilized and poorly drained soils can produce nitrous oxide. Well aerated soils can act as sinks for methane.

Last but not least it has to be stressed that water is a key factor for all major soil functions. Water is of paramount importance for physical (e.g. water as a transport vehicle), chemical (water as major solvent) and biological (e.g. water as basis for any life) processes.

CTT-NC2: Biodiversity, organismic and genetic resources

Soil is the major habitat for organisms (flora and fauna as well as microorganisms). A broad diversity is essential for the stability and resilience of an ecosystem. This is particularly important with regard to climatic extremes which may put a soil under pressure. The so-called “carrying capacity” is linked to diversity. The diversity is important on different levels: (i) Diversity of ecosystems, i.e. different habitats, (ii) diversity of organisms, (iii) diversity of genes (from an agricultural point of view important for future plant breeding), (iv) diversity of functions (e,g, functions can substitute each other which enhances the stability of the ecosystem.

CTT- NC3: Water, water cycle

The hydrological cycle between soil, surface water, groundwater and atmosphere largely relies on an undisturbed landscape. Sealing of soil surfaces, limited river bank infiltration, soil compaction, etc. can interrupt the water cycle and impede the water quality. As a consequence of climatic change parts of Europe may be subject to severe water shortages or surpluses. Both will affect agricultural productivity. In coastal zones a lowering of the groundwater table might enhance the salt water intrusion into the groundwater. In inland areas, an enhanced irrigation and evaporation may lead to a salinization of the agricultural soils.

CTT- NC4: Pollutant degradation, filtering and immobilization capacity

Soils, aquifers and rivers play important roles in pollutant degradation. Organic pollutants (e.g. pesticides) can be degraded by microorganisms, metals can be chemically and biologically converted (e.g. redox reactions). The biological degradation of pesticides was extensively studied by the agrochemical industry. The potential of soils to degrade and detoxify organic pollutants is an outstanding ecosystem service. Metals cannot be degraded but a number of redox reactions in soils may lead to an enhanced mobility (i.e. metals will be washed out) or an enhanced immobility (i.e. metals will be adsorbed to surfaces and thus lower their bioavailability).

CTT-NC5: Prevention of erosion and mud slides, natural hazards

A healthy soil with an adequate plant and tree cover is an important stability factor with regard to erosion, landslides and avalanches. These factors can hardly be matched by technical means. For example, a healthy forest in alpine zones provides a solid avalanche protection. On the other hand, an alpine meadow which is not cultivated any more or which is covered with alder provides a poor avalanche protection. For the sake of completeness it has to be noted that “normal” processes of erosion followed by sediment transport can also be beneficial for low lands.

CTT-NC6: Geological resources

The surface and subsurface, respectively, can offer deposits of minerals (e.g. metals) and building materials (e.g. rocks, gravel, sand). Moreover, it can be a source of energy (e.g. wood, fossil fuels, and geothermal energy). Peat may serve as an example: For centuries in many parts of Europe peat was excavated and used as fuel. As a consequence the ecosystem services associated with peat were reduced (carbon sequestration, intact water cycle, high biodiversity, etc.).

CTT-NC7: Intrinsic values of soils and landscapes

Soils, flora and landscapes have intrinsic values (e.g. aesthetic, cultural and social values) which can hardly be monetized. These values can be a basis for tourism and recreation. “Cultural landscapes”, or man-made landscapes (in German *“Kulturlandschaft”,* in Dutch *“Cultuurlanschap”*) can be unique from a cultural, social and historical point of view. One has to be aware of the fact that these intrinsic values are often public goods (e.g. esthetical value of a landscape, biodiversity on an alpine meadow) whereas the challenges from the demand side are often private interests (e.g. infrastructure for tourism, real estate).

Land Management

CTT-LM 1: Governance, management mechanisms, instruments and policy on Land Management

Governance in the context of land management is defined by the policies, using appropriate instruments and mechanism and the institutional, administrative framework. Making better use of existing instruments as well as introduction of new innovative mechanisms, based on a circular land use approach, will help keep more of Europe's land in beneficial use. The main challenge related to land management governance in Europe is the diversity of administrative and planning systems in EU members' countries as well as dynamic private sector initiatives e.g. in urban development and agriculture. Different countries have taken different approaches to land management and have different planning culture including: law and regulations, fiscal and economic system, complexity of investment's procedure and public information and communication. Content of this topic includes a common focus of many innovative approaches being defined in the partner s' countries as a research needs. These research needs can be further subdivided in four subtopics:

CTT-LM 1.1: Policy and Institutional aspects of land management

Policy and institutional aspects of land management are related to a broad scope of "land management" issues like: political regulations and public involvement, social and environmental needs, right of ownership, financing of land purchase, establishing and enforcing development controls, instruments mechanisms, which are focused on land management. The proposed research topics can be related to the efficiency of administrative procedures, management of land uses and spatial policy coordination. Identifying innovative solutions as well as institutional capacities required to carry out all of these tasks seek to introduce a new, holistic and systemic approach to land management, including urban-rural interaction. The integrated approach to land management reflects importance of co-ordination within broader as well as specific local context. Many research questions which are included in the national reports refer to these aspects of land management.

CTT-LM 1.2: Spatial Planning

Spatial planning goes beyond traditional land-use planning to bring together and integrate policies for development and use of land with other policies and programmes. Spatial planning plays an important role in achieving the spatial relationships between societal needs, economic activities and natural capital stewardship and is designated to regulate use of land balancing private and public interests. In Europe, the relationship between spatial planning and measures to protect and enhance the soil and land varies from system to system. Due to the growing complexity and speed of the changing processes related to the particular context of land, it is more and more important to be able to have a real-time and flexible response to problems and opportunities. A general requirement for better and effective spatial planning is that environmental and societal objectives should be identified at an early stage of the planning process. It is crucial to develop support measures and guidelines that serve this purpose. There is a need to define multi-purpose guidelines which should respect various spatial planning scales (from global to local) and which should strengthen the ability of "land management" to deal with spatial, temporal and sectoral

interdependencies among economic activities and with interrelationships between environmental and socio- economic objectives. Operational elements of spatial planning, e.g. new agencies and revolving funding instruments are required to coordinate different aspects of land management and improving soil land management quality.

CTT-LM 1.3: Conflict management among different land use options

Conflicts are an inherent part of land management. Competition among various land use options could create land use conflicts. Conflicting objectives exist in all types of spaces, on all scales and they reach beyond the set of instruments of spatial planning as “mutual spatial management process”. These conflicts exist, and to deal with them in an adequate way require the scientific basis for the adequate balancing of decisions and proposed solutions. Spatial vision systems are not compatible enough with one another. Also the interdependence of the different actors of land use decisions has been only partially understood up until now and a strong demand exists for empirical research. Better land management and integration of different land use targets could support reconciliation of potential conflicts on different scales and minimize negative impact on society, ecosystem services and quality of space. All topics related to the land management have been also related to the conflict management. From this perspective, conflict management seems to be an important and widespread issue across many countries. Management of conflicts is needed in the context of land ownerships versus public interests, local and worldwide effects (like climate change adaptation, urban- rural interdependencies etc. There is a need to establish an integrated approach to conflict management, which should be coherent with all aspects of land management. There are research needs expressed by INSPIRATION’s National Key Stakeholders to identify stronger involvement of wide range of stake holders especially end- users into the process of land conflict management on to address societal challenges.

CTT-LM 1.4:Circular land use and land management

Land is a finite resource. That is why better land use and management should present a strategic approach for sustainable development of settlement structures as well as efficient use of land as resource. Land-use from the perspective of circular economy refers to circular land use and management. Circular land management also offers a starting point for the achievement of the EU goal ”no net land take by 2050“ and the international goals related to a no–net–land degradation This concept can be described with the slogan “reduce - recycle – avoid”, and is focused on new, innovative ways to minimize the consumption of land by reusing and redevelopment of, derelict and under-used land sites as well as on de-sealing abandoned brownfields as a compensation measure for newly urbanised areas in order to achieve a zero land take balance..In this context, the circular land management concept presents a comprehensive strategic approach for steering the development of settlement structures. Circular land management also offers a starting point for the achievement of the EU goal ”no net land take by 2050“ and the international goals related to a no–net–land degradation. Furthermore, circular land management can contribute to the implementation of strategies for climate adaption and “healthy” cities. Research is required to understand the patterns of behaviour and interdependencies of actors active in land-related policy areas. It is important to combine the strategies and instruments of circular land management through applied research and pilot case studies and in the sense of modular “tool boxes” to qualify a

sustainable land management. As a part of sustainable land use the circular material management should be included. Since many European standards are affected by this, this action should take place on the European level.

CTT-LM 2: Climate changes challenges for land management

Climate change affects all European countries. It is seen as a serious challenge for the urban areas as well as for rural areas on different scales. Climate changes all over Europe are increasing the danger of droughts, floods, landslides and other hazards, affecting both the quality of life of people and economy/businesses development. The comprehensive understanding about the processes resulting from climate change should be deepened, and better knowledge is needed for more effective and suitable land use management. Due to global aspectsc climate change should be regarded differently than the other societal challenges. The main focus should be on the protection of environment and the support of sustainability within the changing conditions as a result of climate change. Nevertheless, climate change is seen to be the number one threat as it is a very complex problem, therefore needing integrated, cross-sectoral solutions. Extreme weather events, flooding, drought and environmental stresses impose new demand on spatial planning and land management. Spatial planning is an instrument for coping with effects of climate change and land management can be a strong instrument supporting development and implementation of counteracting negative climate phenomena. There is awareness on climate change as a societal challenge, that's why decision makers need to better integrate strategies for dealing with climate change into their development plans, rather than leaving them isolated as stand-alone policies and projects.

There is a need to work out land management instruments supporting climate change adaptation in the context of improving preparation for unexpected climate conditions in natural, semi-natural and built-up areas (rural and urban), through strengthening their resilience. Development of green infrastructure and nature-based solutions could enhance role of ecosystems services in the processes of strengthening this resilience.

CTT-LM 3: Land as a resources in urban areas (Sustainable urban land management)

Sustainable urban land management is referring to SDG Goal 11: Make cities inclusive, safe, resilient and sustainable. Cities build diversified and dynamic economies, and become the key engines of development (by 2030, almost 60% European population lives in cities, towns and suburbs1. It is widely recognized that cities play a vital role in social and economic development of all European countries. However many growing and shrinking cities have difficulties related to economic, environmental and societal problems closely related to the transition of land. Sustainable urban land management is essential for innovative and effective approach of urban policy (e.g. compact cities, smart cities, healthy cities…). Increasing urban density reduces the effectiveness of urban solutions to hazards management and increases the need for costly engineering solutions. That' why one of most important questions is: How to improve the cross-sectoral implication of urban development? The other important part of urban land management is referring to the necessity of efficient (re)use of land resources: such as water, energy, and reuse of derelict, degraded and post-

[1] http://www.un.org/sustainabledevelopment/cities/ and http://www.eea.europa.eu

industrial urban sites. That's why is important to establish integrated solutions related to the multiple reused urban land, including those areas which recognised as a city's Brownfield's.

Main challenge for sustainable urban management is to find ways of balancing the needs and pressures of urban growth with the opportunities and constraints of the environment. Once a solution was found and agreed, implementation structures are required to avoid deadlocks. In this context further research-fields are: impacts of demographic change, economical effects of urban sprawl, nature protection in urban space sand role of urban green infrastructure and nature – based solution, brownfield revitalisation, improvement of quality and efficiency of urban infrastructure, (multifunctional use and flexibility of buildings and infrastructure), governance of urban structure such as, urban agglomeration, polycentric conurbation and functional urban areas.

CTT-LM 4: Land as a resources in rural areas (Multifunctionality of rural areas)

Sustainable urban land management is referring to SDG Goal 15:: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.Land-use transition through agricultural production and the development of the countryside settlement structure are closely related to one another and the rural ecosystem services. There are a number of factors related to the transition of agriculture to urban land. Most important is the pressure on high quality soils by new settlements, which lead to urban sprawl and high level of soil sealing. Also demographic change and migration from rural to urban areas play important role in this process .However transition process also offers chances for experiments, new users and uses. Limited natural resources such as water and soil should be used and managed following the principle of sustainability, in order to preserve them for the next generations.

Due to high levels of urbanization in Europe, keeping balance between urban and rural areas became a crucial issue especially in the context of soil protection and land management in peri-urban and rural areas. Effects of loss of high quality agricultural land due to other land uses, e.g. energy production became a challenge for development of the rural areas. It should avoid extensive use of land, ensure soil protection, limit soil-sealing. Improvement of management measures for the cultivation of agricultural land is a very urgent topic because it addresses people worldwide. Implementable solutions with regard to regional adaptation are necessary. An international implementation of improved management measures will have a tremendous impact for small- and large-scale farmers. Sustainable use of the soil and multifunctional rural development could contribute to tackle societal challenges without losing soil quality. Environmental issues in rural areas are almost always related to environmental-development relationships like productivity and sensitivity of natural systems, as well as environmental hazards risk. Research in the field of "Rural Areas, Landscape Transition and Ecosystem Services" is needed on management and steering mechanisms, the development of the land/real estate market and environmental compensation measures linked to ecosystem services. Other important field of research related to the management of rural,, areas are:: innovative management of agricultural land. respecting their multifunctionality, pressure on high quality soils by settlement and species conservation, public awareness, on the economical, ecological and social value of landscape, biodiversity versus fertility of soils, role of soil-sediment-water-systems in planning procedures, long-term safeguarding of food security.

Net Impact on global, EU and local scale

CTT-NI 1: Developing impact assessment methodology

This topic clusters R&I needs regarding methodological development of impact assessment approaches. The research needs can be further subdivided in six subtopics:

CTT-NI 1.1: Development of methods and indicators to assess and monitor changes in SSW and net impact on human well-being and economic prosperity

Despite a basic understanding of the connection between drivers of change and impacts on biodiversity, ecosystem integrity, human well-being or economic development, there is often a lack of appropriate indicators, monitoring systems and tools to assess magnitude of drivers and their impact on the SSW. A better monitoring of indicative indicators would help to inform decision making, e.g. via the monitoring of threshold values or the development of early warning systems, thereby reducing unintended or unforeseen environmental degradation and enhancing the net impact of land management to address societal challenges. In general, there is a need to develop an implementable set of indicators to monitor and evaluate the impact of e.g. use of natural resources, annual land consumption for housing and traffic or the vulnerability and risks due to impacts of climate change, floods, fire, landslides, summer tourism peaks, and depopulation etc. Depending on risk parameters, there is a need for short, medium and long term indicators that may respond to regional specificities.

CTT-NI 1.2: Harmonization and standardisation in data collection and access

A huge challenge for assessing net impact of land management is to identify (monitor) data needs, harmonize and standardise data formats and make available data better accessible for different stakeholders. In this regard, a range of research needs were expressed by INSPIRATION's National Key Stakeholders: There is a need for harmonized methods for comparability, reproducibility and transparency of data collection and management and to link data across different scales, e.g. from global to local scale in climate change modelling. There were questions on how increasing availability of data due to better measuring and monitoring (big data) impact land management and respective policies. Moreover, what are challenges for data requirements, sampling and handling under rapid changes in economic development, e.g. industry 4.0? It is expected, that optimized and harmonized delivery and utility of (monitoring) data will be more cost-effective and beneficial for innovative research, support in land management and policy formulation, while also promoting public awareness.

CTT-NI 1.3: Developing risk / impact assessments methods

For certain activities, drivers of environmental change and associated risks there is a need to develop new assessment methods or to enhance existing tools and methods. A better understanding of cause-effect relationships would enable decision makers to manage land with more security on short, medium, and long term. A low uncertainty, e.g. on health impacts would favour swift decisions and flexibility in delivering permits for specific uses on land and (if necessary) under specific servitudes.

CTT-NI 1.4: Methodologies to analyse net impact of governance models and science

There is a call for adaptive governance models that enhance stakeholder participation in all and already at very early stages of decision-making or co-designing research (see also CTT-NI 4). By now, however, it is not clear, how the success of such new approaches in terms of increased effectiveness / efficiency of policy / planning solutions or usefulness and applicability of research results can be assessed. In this regard, several countries are calling for the development of methodology to better understand the roles of actors in decision-making and explore the net impact of innovative governance models, increased stakeholder participation in decision-making and setting research priorities and to guide the development of related infrastructures.

CTT-NI 1.5: Integrated evaluation of impacts on ecosystem services

Currently, high expectations are placed on initiatives that aim at making nature's economic values visible and mainstreamed into decision-making at all levels. A structured approach to valuation can help decision-makers to recognize the wide range of benefits provided by ecosystems and biodiversity and capturing nature's economic values in decision-making can contribute to sustainable development and to optimize decision making processes. However, economic valuation is contested: Is a monetisation of ecosystem services necessary to achieve cost transparency and global equality? Is the decoupling of economy and environmental effects a sustainable solution for the value assessment of soil? Against this background, a range of research needs are articulated in national reports.

CTT-NI 1.6: Development of alternative impact metrics

Besides established impact metrics, such as biophysical, economic or health effects that are often looked in separation, there is a call for developing systemic or holistic evaluation approaches that are able to link impacts at different scales in space and time as well as between different types of impacts. There is also a call for metrics that allow the evaluation of intangibles, and enhance qualitative assessments. In this way, it is expected that decision-making could be better informed and the complex interlinkage between action and impacts could be better communicated.

CTT-NI 2: Understanding and assessing impacts of drivers and management

This topic clusters research and innovation needs regarding the identification (why and where are there impacts?) and the assessment (what is the impact?) of (yet unknown) impacts of different drivers of environmental change in five dimensions:

CTT-NI 2.1: Understanding impacts of climate change

There is a need to better assess impacts of climate change to prevent long-term consequences that might grow to an extent and magnitude unable to be controlled. Proper land use management systems have to be design in order to mitigate climate change impact with regard to carbon sequestration in agricultural and forestry lands, reducing agricultural land CH_4 and NO_2 emissions, or providing biomass for biofuels as well as to support the design of adequate land management strategies to adapt to climate change impacts.

CTT-NI 2.2: Understanding the net impact of land management decisions

There is a call to improve the knowledge about socio-economic and environmental benefits and costs resulting from different land management strategies in order to raise social awareness and to support decision-makers in land management and policy. There is a range of research questions asking for the impact of land use and land use changes on ecosystem provision and (changes in) organic carbon, soil fertility, soil erosion or water quality. What are the 4D (x,y,z and t) effects of land use and interferences in the natural system? What are the long term impacts of management practices on different soils under various climate conditions? What are comparative (dis-)advantages of different land use intensities or practices, e.g. in agriculture or forestry? What is the impact of urbanisation on the SSW-system but also on human health and vulnerability to climate change? It is expected, that such knowledge will improve competitiveness and sustainability of land management.

CTT-NI 2.3: Understanding impacts of (new) contaminants

There is a lack of information about the impact of ‘new’ or ‘emerging’ contaminants on soils and surface water bodies as well as groundwater (see also CTT NI-1). There is a serious lack of knowledge about contaminants properties and distribution in the different environmental matrices and their interaction with health. Moreover, there is a need to better understand the impact of mixed pollutants coming from a range of different sources. Research could help to close gaps in law dealing with (emerging) pollutants and their consequences on the environment and people's health.

CTT-NI 2.5: Understanding the net impact of policies, planning and regulations

Policies, planning and regulation shape the decision-making space for land users, producers and consumers as well as citizens and may thereby steer land management towards meeting the societal challenges. There is, however, a lack of understanding of the real impact of policies, planning and regulations and what makes a policy impetus effective or not. Also, there is a need to better understand the role of different administrative bodies in decision-making on setting up policies and planning.

CTT-NI 3: Trade-off analysis & decision support

Research needs under this topic are concerned with analysing synergies and trade-offs between different (societal) goals with regard to land use as well as research needs regarding the comparative assessment of management options to balance conflicting demands. Such analysis is demanded as an input for transparent and evidence-based policy-making.

CTT-NI 3.1: Dealing with conflicts and promoting synergies of societal goals

Given the scarcity of resources and the overall limits of natural capital, conflicts and trade-offs between the realizations of different societal goals regarding land use and land management will be inevitably. Research questions clustered under this subtopic aim at identifying trade-offs as well as synergies and by assessing the relative importance of conflicting goals provide guidance for policy-making on how to go about these trade-offs or to realize synergies.

CTT-NI 3.2: Identifying cost-effective solutions for land management

There are research needs expressed by INSPIRATION's National Key Stakeholders to identify cost-effective solutions to address societal challenges. For example, how to identify most cost-effective remediation measures for contamination / brownfield revitalization? How can we deal with temporal distortions, e.g. some measures can be more expensive than business as usual but on long term save cost (or give high societal benefits)? How can costs and effectiveness of climate change mitigation and adaption measures be assessed and compared? How to deal with different benefits (social, health, economic, ecological) in cost-effectiveness considerations? What is the contribution of public green space / green infrastructure for human well-being / in climate change adaptation? How to adapt land management in agriculture and forestry to fully deploy the multifunctionality of these land uses? Research will help to develop land management strategies with the lowest negative impacts. It will also guide policy-makers in designing regulations and support scheme to promote such cost-effective management strategies.

CTT-NI 3.3: Towards spatially optimized land use / land management

In order to best address the societal challenges of a resource-efficient development, land uses have to be spatially optimized to reduce negative impacts while realising synergies. In this regard a range of research questions were raised by INSPIRATION's National Key Stakeholders: Which type of land should be used for specific functions? What is the best use of land and what are the good uses of land; and in contrast, where should certain land uses be not allowed? The aim is to develop visions for spatial planning and policy-making of how land is to be used in future, how cities and municipalities are to be planned, how the landscape to be developed.

CTT-NI 4: Science-Society-Policy Interface

This topic clusters research needs on how to enhance knowledge uptake and acceptability of policy measures to alter land-use decision with the ultimate goal to improve the net impacts of land management.

CTT-NI 4.1: Awareness Raising to facilitate communication, stimulate behavioral change and increase acceptance

Awareness Raising is seen as a critical factor to enhance people's willingness to be actively engaged in decision-making via participation procedures, to facilitate uptake of knowledge in policy-making and land management, as well as acceptance of policies and planning to reduce negative impacts of land use decisions – all of this contributing to the ultimate goal of improving land management. Against this background, research needs were expressed on what factors facilitate communication and raise awareness among decision-makers as well as the broader public? And what infrastructure is needed to support awareness raising and to promote a change in behavior?

CTT-NI 4.2: Enhancing stakeholder participation

It is widely accepted that stakeholder participation can facilitate acceptance, effectiveness and efficiency of planning and policy-making, e.g. by ensuring the development of more

easily utilized solutions as well as building public understanding and trust through informal and formal communication processes. There is also a trend towards bottom up activities in decision-making but a lack of knowledge and understanding about the reasons for the development of such initiatives and about their long term consequences and impacts. Against this background a range of research questions were identified and answers to these questions are deemed to be crucial to advance the positive effects of stakeholder participation for better managing land use conflicts.

CTT-NI 4.3: Sharing knowledge effectively

A common statement of INSPIRATION's National Key Stakeholder is that there is a lot of knowledge on how to enhance net impact of land management available; however, it is not disseminated to relevant stakeholder (from science to policy and administration on to end-users as well as the other way round) nor implemented in practice. An essential key to improve the situation is to facilitate knowledge transfer. In this regard it is necessary to understand how knowledge transfer works and what necessary infrastructures and support measures are, what kind of legal constraints (e.g. intellectual property rights) on knowledge exchange have to be considered and the market uptake of innovative solutions can be accelerated.

CTT-NI 4.4: Facilitating policy integration

Land use and land use change is influenced by many different policy sectors aiming at different, sometimes conflicting goals, e.g. housing & traffic, agriculture & forestry, climate mitigation & adaptation, water management, or nature conservation (see CTT-NI 3). As a result, there are many side-effects of sectoral policies, some of them intended, others occurring unintended. In order to facilitate the realisation of synergies and avoid / minimize conflicts of policies, there is a call for policy integration, to consider all relevant effects. It is unclear however, what tools and infrastructures are necessary to facilitate such policy integration and R&I needs are formulated in many national reports.

Integrated Research Topics (IRTs)

IRT-1: Integrated Environmental Assessment and Soil Monitoring for Europe

Theme proposed by F. Glante, S. Bartke (UBA)

Background: The ENVironmental ASsessment of Soil for mOnitoring (ENVASSO) Project was funded as Scientific Support to Policy (SSP) under the European Commission 6th Framework Programme (Contract 022713, 2006- 8). The main task was to document existing soil monitoring schemes in 25 EU member states and to give an outline for a European-wide monitoring network to assess the state of European soils and trends of soil properties. ENVASSO also proposed a number of new monitoring sites to complete the network for overall Europe. (http://esdac.jrc.ec.europa.eu/projects/envasso). – So far, soil monitoring networks have focused on assessing the trends of hazardous compounds in soil, soil biology, erosion, and in some intensive monitoring sites also fluxes of compounds between soil and groundwater. But meanwhile, a number of questions arose that cannot be answered by "classical" monitoring. These are related to e.g. topics of climate change, food security, SDG implementation and accounting, and challenges in land-use changes. How can we achieve the connection of established networks and the integration of new networks in a way that ensures broad data availability (open data)? Are new statistical methods needed given the new demand for data and reporting? – Although ENVASSO proposed a European wide cooperation, and although on the EEA/JRC-level the European Data Center was established, a network of monitoring systems is still waiting to come to power. There a some surveys done in Europe like geochemical mapping of agricultural and grazing land soil (GEMAS), the forest soil survey or LUCAS-soil run by JRC but the future / replication of these activities is not sure and cannot replace a true monitoring. Nevertheless the harmonized methods should be taken into account in future harmonization activities, – New regulation (like INSPIRE) for data exchange has to take into force, but still research is needed to answer to knowledge gaps (parameters, indicators, scale). The remote sensing techniques, like the COPERNICUS program, might bring new data and information needed as background data for the monitoring.

Goal: Give an actual proposal for a European wide soil monitoring network to provide an information and data tool for scientists and decision makers. How to meet the land degradation neutrality target? Define Status of the soils in Europe and the trends of changes – either in soil / land use but also in impacts to the soils (chemical, biological and physicacal changes of soil functions). There is a definition needed: What is good soil quality – for which purposes? So soil quality targets should be elaborated.

So what? Monitoring might show us when soils quality decreases to a level harmful to soil functions, food security and human health. It is one of the most important instruments counting the level of land degradation – and a measure to indicate if we achieve land degradation neutrality. A long term funding is needed to have results of – most – slowly reacting soil properties but to find an early warning system if harmful changes nay occur.

Links to other fields: There is also a link to the problem of refugees, land abandonment / degradation in states suffering from war and conflicts, and problems of resettlement from rural to urban areas. These scenarios have also taken into account. Links to existing H2020-projects should be taken into account like the ISQAPER-Project.

Exemplified research questions

- How can (efforts and) results of soil quality can be monitored and by the use of which indicators? How could it be used for communication and monitoring (e.g. a threshold value)? What indicators should be used to quantify soil degradation?
- How could new methods like remote sensing (e.g. COPERNICUS data) support soil monitoring?
- What data and system concepts are needed to harmonize monitoring data and make them available on a European scale? How could we deal with heterogeneous data and which statistical methods can be used for monitoring purposes (geo-statistics, new statistical procedures)?
- How can surveys like the forest soil survey and permanent field experiments be used for monitoring purposes?
- How do we define and consequently monitor degradation neutrality?
- How could we monitor soil rehabilitation?

Characteristics of IRT-1: Integrated environmental assessment and soil monitoring for Europe	
Links to identified research gaps	Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
National research topics	AT 5; BE 1, 18; CH 2-7, 4-1, 4-4; DE 3-2, 4-1, 4-2, 5.5; ES 1, 3.5; IT 3, 3.4; FR 4; NL 5, 7; PL 4; PT 1, 2, 9; SE 8, 9
Clustered thematic topics	Demand: CTT-D1, 2, 3, 4 Natural Capital: CTT-NC1, 2, 3, 5, 7 Land Management: CTT-LM1.1, 1.3, 1.4, 3, 4 Net Impact CTT-NI1.1, 1.2, 1.3, 1.6, 2.1, 2.2, 3.2, 3.3, 4.1, 4.3

IRT-2: Recognizing the values of ecosystem services in land use decisions

Theme proposed by C. Schröter-Schlaack (UFZ) / J. Zeyer (ETH)

Background: Ecosystem services underpin human well-being and economic prosperity. Land use, such as agricultural production or forestry, and land use change, such as urban development, agricultural intensification or afforestation is influencing the bundle of ecosystem services provided. Few ecosystem services have explicit prices or are traded in markets and more often than not these marketable ecosystem services (typically, provision services such as crops or timber) are preferred over non-marketable services (e.g. regulating and cultural services, such as freshwater provision, mitigation of hazardous events or landscape beauty) in decisions about land use and land use intensity. Yet also these non-marketable ecosystem services are important to human well-being and people may hold substantial values for them, irrespectively whether they can be sold on markets or not. There is thus a huge challenge to identify and assess the benefits of such non-marketable ecosystem services affected by changes in land use and land use intensity. While many past and ongoing research projects are contributing to the assessment of the manifold values of ecosystem services, there is still a lack of consent on how these yet neglected values can be integrated (e.g. via hybrid valuation methodologies) and thoroughly recognized in decision-making. Thus, understanding driving forces of decision-making at different levels (local to national and even global), such as market trends, institutional settings, knowledge diffusion,

technology development and policy incentives is another prerequisite to design land use policies that support the provision of better balanced ecosystem service bundles.

Goal: Explore on options, how the importance of the whole range of ecosystem services linked to changes in land use and land use intensity can be assessed, integrated and better recognized in decision-making and developing land use policies. Concepts should be based on recent studies, such as the MEA, TEEB and CICES systems.

So what? Assessing magnitude and societal distribution of costs and benefits of different land use options (e.g. through cost-benefit analysis, cost-effectiveness analysis or multi-criteria analysis) can help mainstreaming the values of nature and ecosystem services into decision-making.

Links to other fields: The key problem of valuing ecosystem services and value integration is evident in a number of conflicts at the interface society/economy/environment. For example (i) intensity of agricultural production (ii) greenfield development for housing, industry or traffic, (iii) forest management and afforestation or (iv) deep sea fishing versus fish diversity and abundance of fish populations to name but a few.

Exemplified research questions

- What new metrics are required to assess socio-economic, socio-cultural and environmental impacts and benefits of different land management strategies in response to (new) challenges, e.g. climate change mitigation & adaptation, demand for food, fuel, forest & fiber, housing, tourism & recreation, nature conservation?
- How can a new “value” framework, enabling better balance of benefits vs costs could look like? Valuation tools should give more weight to health, environmental and cultural parameters and should take ethical considerations into account.
- How to map and assess soil ecosystem services? How to value soil ecosystem services? How can the “bundle” of ecosystem services be gathered and evaluated? All stakeholders (including policymakers) need to take into account the value of the different soil ecosystem services in their processes and projects: how to do that?
- How can the accessibility and resolution of data on ecosystem services at relevant levels of decision-making (and in particular at local and regional level) be enhanced?
- How do stakeholders value ecosystem services and how can these result in social, economic and environmental development?

Characteristics of IRT-2: Recognizing the values of ecosystem services in land use decisions	
Links to identified research gaps	Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
National research topics	AT-9; BE-15; BE-28; FI-10; FR-2; DE-3.5; DE-6.2; IT-1; IT-4; PL-4; PT-1; PT-2; PT-4; PT-7; PT-8; Sl-1; ES-3.7; ES-3.14; SW-5; SW-7; SW-8; SW-9; CH-2.5; CH-2.12; NL-1; NL-2
Clustered thematic topics	Demand: CTT-D1, 2, 4, 7 Natural Capital: CTT-NC7 Land Management: CTT-LM1, 4 Net Impact CTT-NI1.4, 1.5, 1.6, 2.2, 2.4, 2.5

IRT-3: From indicators to implementation: Integrated tools for a holistic assessment of agricultural and forest land use

Theme proposed by F. Makeschin (DIU)

Background: Natural capital and land use systems are subjected by diverse disturbances and stressors. Although manifold scientific indicators are available for an ecological and socio-economic evaluation of land-use impacts, most of these used are still discipline- and sector-oriented. Examples for it are using soil chemical parameter exclusively for the productivity of sites without considering water quality or soil biodiversity indicators as sustainability criteria for land use too, or evaluating land use impacts restricted on a single field or site, whereas an interdisciplinary and spatial assessment would be necessary to integrate also the diverse impacts on a small or medium scaled landscape or regional level. Due to the complexity of factors to be involved for an integrative assessment of land use, appropriate tools for evaluation, planning, commercial and political decisions are still lacking. Thus science-based methodologies and assessment approaches are necessary for end-users like farmers or forest managers, planners and decision makers.

Goal: Elaborate end-user friendly tools for an integrated assessment of agricultural and forest land use.

So what? Currently administrations, decision makers and different scientific disciplines work on assessment methodologies in parallel. As a rule, assessment approaches are based on segregated procedures (with focus on ecological, economic, social or planning aspects), and lacking on a spatial and cross-disciplinary indication. Thus research is necessary to bridge disciplinary sectors and to develop (regional or land use type specific) methodologies for an integrated assessment manageable and implementable for end-users. Integrated tools aiming on the needs of land users, planners, landscape ecologists and decision makers have to be developed by an intensive participation of these end-users. Research should consider the current state of the art of sectoral and disciplinary methods and criteria and existing best-practice approaches on the one hand, and manageable tools and algorithms (in the sense of summary indicators) specific to agricultural or forest land use types or climatic regions (e.g. Nordic, Mediterranean) integrating also societal demands and the socio-cultural background of regions on the other.

Links to other fields: Main gap is elaborating integrated ecological indicators (key) bridging to / with socio-economic and planning instruments and tools.

Exemplified research questions

- How soil and water-related ecosystem services can be taken into account in land use planning?
- Which regional indicators and target values (e.g. sealing, flood protection, building density, type of agricultural cultivation) could support sustainable land use? How can they be implemented?
- Develop an implementable set of indicators to monitor and evaluate the impact of e.g. annual maximum land consumption, climate change effects or sustainable land use.
- How should an adequate tool for the assessment of soil quality look like for soil sciences and spatial planning?
- How to achieve comparable and harmonized data across Europe?

- How to prevent, map and monitor, evaluate risks, remediate or manage diffuse contamination in soil, groundwater and sediments?
- What is the contribution of soil to water retention?
- How to improve analysis methods and multidisciplinary use of different sources of data (field observations, geophysical mapping, observations made by citizens, remote sensing and other GIS-based data as well as modeling and model-based data)?
- What would the criteria and ways to comprehensively assess the use of natural resources?

Characteristics of IRT-3: From indicators to implementation: Integrated tools for a holistic impact and land use assessment	
Links to identified research gaps	Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
National research topics	Proposal is based on cross-sectoral research themes in D 2.5: executive summaries and overarching research needs.
Clustered thematic topics	Demand: CTT-D1, 2 ,4 ,5 ,6 ,7 Natural Capital: CTT-NC1, 3, 5, 7 Land Management: CTT-LM1.2, 1.3, 3, 4 Net Impact CTT-NI1.1, 1.2, 1.3, 1.5

IRT-4: Bio-Economy – unleashing the potentials while sustaining soils

Theme proposed by S. Bartke (UBA)

Background: Europe aims at a resource-efficient and sustainable economy. Europe's Bioeconomy Strategy (2012, to be reviewed in 2017) is claimed to be a building block of a circular and more sustainable economy. The bioeconomy comprises those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and energy. The bioeconomy promises a step-change where fossil fuels are replaced with sustainable natural alternatives as part of the shift to a post-petroleum society. The bioeconomy enables independence from finite fossil resources, however, it relies crucially on the provision of biomass and energy to be provided by the soil-sediment-water-system and the rivers and seas. In particular, the capacities of soils and their sustainable potentials to enable a bioeconomy with adequate agriculture and foresting are critical.

By taking an integrated systemic approach, there is a need extend the understanding of the complex and interrelated factors involved throughout the biomass production and consumption chain. There is an urgent need to put in place measures to better understand and limit risks and environmental impacts (e.g. understanding and minimizing negative externalities) and better cope with varying conditions and seize opportunities for new ways of production, while respecting the sustainable limits of soils to provide the renewable resources. Not least, the socio-economic drivers and inhibitors (e.g. related to regulation and acceptance) of changing to a sustainable bioeconomy need to be considered comprehensively to understand the next to the technological also the societal potentials and

limits of intensification of soil use in order to accordingly steer production as well as behavioral change in agriculture, industrial processing and consumption effectively.

Goal: Unleash the potentials of soils to sustain a bio-economy in Europe by better understanding soil and economic systems in order to derive more sustainable land management, biomass production and consumption

So what? Fossil resources are limited and in the long run alternatives are needed. Soils can provide bio-based resources, but their provisioning needs to be sustained and an overuse of soils must be prevented, because this could deeply impact the soil system functioning. If we do not find efficient means to utilized the potentials of soils to supply enough produce to satisfy society's demands, severe competition of needs will need to be managed.

Links to other fields: Next to soil, also water and sediments are used in a bio-economy and research is linked to the broader system.

Exemplified research questions

- What is the production capacity of soil to support a bioeconomy? Is there enough soil and how to use it best? → What is and how to achieve a bioeconomic optimal functional landscape organization? What is the efficient production and consumption spatial level (local, regional … global – for which goods)?
- How to model complex soil system interactions to understand critical limits, tipping points of provision of soil services and the externalities beyond the production of a single desired biomass good?
- How sustainable can a bioeconomy be? In how far must a bioeconomy be a circular economy approach? What might be unwanted impacts of a bioeconomy? What knowledge is needed?
- How to measure the success of bioeconomy? What are measures for the impact and for the policy effectiveness?
- How to optimize cascade and circular use systems of agricultural products to minimize demand for soil produce? How can re-cultivation of soil be achieved? Which methods enable reclamation of land for bioeconomic production? How to raise awareness for the hidden potentials? How to optimize soil fertility? How to use more waste and minimize resource input? How to balance the conflict of exploiting biomass from soils and returning organic matter to soils?
- How to raise awareness and production for the different ecosystem services of soils as products for the society (e.g. water purification, carbon sequestration)?
- How to steer consumption to more sustainable, bio-based products? How to drive change of consumer preferences? What are socio-economic and cultural gaps to be bridged on the path to a sustainable bioeconomy?
- How to steer with an adequate policy mix and regulatory environment from the European to local level the change to a bioeconomy, in particular as related to sustainable soil management (but also considering the full production and consumption chain of biobased products and energy – and the diversity of Europe)? How can business, producers and government draw up agreements toward a sustainable bioeconomy?

Characteristics of IRT-4: Bio-Economy – unleashing the potentials while sustaining soils		
Links to identified research gaps		Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
	National research topics	AT 1, 2, 3, 7, 9; BE 1, 3, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 22, 23, 25, 28, 29; CZ 3, 5, 7; FI 3, 4, 5, 6, 7, 8, 9, 15, 16; FR 1, 2, 3, 4, 5; DE 2.2, 2.3, 3.2, 3.3, 3.5, 4.1, 4.2, 5.1, 5.2, 5.3, 5.4, 5.5, 6.3, 8-1, 9; IT-1, 4; PL 2; PT 1, 2, 3, 5, 7, 8, 9, 10; RO 1, 2, 3; SR-1, 2, 5, 6, 9; SI 2, 3; ES 3.2, 3.3, 3.7, 3.8, 3.9, 3.11, 4; SE 1, 3, 5, 6, 8; CH 2.2, 2,5, 2.10, 2.12, 3.1, 3.2, 3.3, 3.4, 4.1, 4.2, 5.4; NL 1, 2, 7, 8, 9, 12, 13, 15; UK 1, 3, 4, 5, 6, 7, 8, 9, 11, 12
	Clustered thematic topics	Demand: CTT-D1, 2 Natural Capital: CTT-NC1, 2 Land Management: CTT-LM1.1, 1.2, 1.3, 4 Net Impact CTT-NI1.1, 1.5, 2.2, 3.3

IRT-5: Integrated scenarios for the Land-Soil-Water-Food nexus under societal pressures and challenges

Theme proposed by F. Glante (UBA)

Background: Societal challenges impact on how humans exploit natural resources. Only few integrated scenarios exist, which include changes in soil properties, water availability, food, and timber, fibre, or bio-energy production. Consequently, mutual synergies and trade-offs, what is often referred to as the nexus, remain unknown or unconsidered. Future scenarios do exist for the impact of land use and land cover change on climate and biodiversity but not vice versa, e.g. impact of biodiversity changes due to climate change on soil properties. A few integrated scenarios do exist, which include food production, bio-energy and wood biomass production, climate change and biodiversity, exploring pathways for achieving corresponding global targets. The results show a possibility to meet the demand for food and energy security but without achieving international climate and biodiversity targets at the same time. The integrated scenarios, which have been developed so far, have not taken into account the impacts on soil, water availability, floods and droughts; the timber and fibre production; nor their vital feedback on food, bio energy, climate and biodiversity and vice versa. To find out what scenarios benefit to the society AND to the environment very comprehensive scenarios have to be elaborated. The results may be lead to soil management and to spatial planning as well.

Goal: Elaborating explorative and target oriented scenarios considering integrated, spatially-explicit models that take into account major trade-offs and synergies between ecosystem functions, land use and societal challenges. External effects of our economy (import of goods, environmental footprint into developing countries) should be taken into account as well.

So what? Caused by a growing population, increasing soil and land degradation the remaining scarce fertile soils with good properties are in danger to become overused. This may lead again to more degradation. To know by modeling scenarios and to assess the major impacts in every scenarios might decrease further degradation, secure food and give answers to the way how to reach the target of land degradation neutrality. Changes in the

economy and the society should estimate like growing / shrinking areas and their impact to the land-soil-sediment-water nexus.

Links to other fields: There is also a link to the problem of refugees, land abandonment / degradation in states suffering from war and conflicts, and problems of resettlement from rural to urban areas. These scenarios have also taken into account.

Exemplified research questions

- Who needs the scenarios most? What legal instruments are needed to implement the results / options of the scenarios?
- Under which scenarios of land use is the impact on soil properties tolerable with regard to food safety, biodiversity, and land degradation neutrality?
- How could we assess overuse of soils?
- What are the key drivers and inhibitors of futre developments that impact the quality and availability of fertile soils?
- How can we compensate the gap between demand and existing soil properties by sustainable land management and how can we remediate degradation?
- What alternatives are given beside typical agriculture (urban agriculture)?
- What measure should be taken to reduce the flow from (young) population to urban areas?
- What scenarios can be elaborated for investment in agriculture but to avoid land grabbing, land speculation?
- What measures have to be developed to compensate impact on soils and climate?
- How can we link in ideas on ecosystem services and 'soil resilience'? How does soil quality affect the wider system (and vice versa)?
- How can threats to food security caused by climate change and other ecosystem changes or collapses be managed and avoided?
- How the information of scenarios can be implement in the common agricultural policy (CAP)?
- Which scenarios do we have for "sustainable" or "ecological" intensification (definition, impact, consequences)?

Characteristics of IRT-5: Integrated scenarios for the Soil-Water-Food nexus under societal challenges		
Links to identified research gaps		Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
	National research topics	AT 5, 8; BE 22, 27; CZ 6; DE 1.2, 2.2, 3.2, 3.4, 3.5, 4.1, 4.2, 6.2; ES 3.1, 3.13, 3.15, 3.5; NL 13; FI 5, 7; PT 4; S 4; SE 5, 8; SR 5; UK 4
	Clustered thematic topics	Demand: CTT-D1, 2, 3, 7 Natural Capital: CTT-NC1, 2, 3, 5, 7 Land Management: CTT-LM1, 2, 4 Net Impact CTT-NI1, 2, 3, 4

IRT-6: Indicators for assessing the efficiency of the Soil-Sediment-Water-energy nexus of resources

Theme proposed by J. Villeneuve (BRGM)

Background: The responsibility for a sustainable handling and management of natural resources is indispensable for providing the needs of a growing and affluent population and at once to safeguard the environment. Particularly, the EU's growth strategy for a smart, inclusive and sustainable economy (Europe 2020 strategy) supports a shift towards sustainable growth via a resource-efficient, low-carbon economy. Further, the move "Towards a Circular Economy" is supported by measures driving a more efficient use of resources and waste minimization.

At present, the resource efficiency indicators available in the Eurostat scoreboard represent the evolution of the relation of gross domestic product (GDP) with different inputs such as energy, water, land or material resources (including biomass and minerals). Biomass production (food, feed, fiber, fuels – 4Fs) is the result of the use of the interconnected resources soils/sediments, water and energy. This nexus of resources is not accounted as such in the indicators. Further, there is still at the moment a "conceptual gap" in the method for accounting of biomass in the "resource efficiency", as most of it is produced by humans. The relations between the production of biomass and the use of the soil-water-energy nexus need further investigations.

Goal: The goal is to understand the links between the consumption of our societies and the use of the SSW system services: the need is to quantify and map in time and space the systemic aspects of the nexus of SSW and energy resources.

So what? Most of the competencies of territorial authorities (national, regional, local) are organized by domain (e.g. water, agriculture, urban planning, tourism). These authorities would beneficiate from a more global and informed vision of the utility (private and public) of their decisions if they were supplied with indicators helping to measure the consequences of their decisions on the natural resources. In the future, this "footprint" type of indicators will permit the statistical scoreboard to be complemented to analyze the environmental impacts through the whole global economic cycle and thus to better balance the societal benefits and ecological effects of different resource-use options.

Links to other fields: This IT can be part of researches on more complete resource nexus (water-energy-food, minerals-water-energy, water-energy-minerals-food-land).

Exemplified research questions

- What are criteria and ways to comprehensively assess the use of natural resources?
- How to achieve integration of approaches, solutions and policies in the nexus between the use of water, energy and food to support utilization of natural resources?
- What importance do ecosystem services have in their relations to one another?
- Which indicators can improve the evaluation of qualitative and quantitative aspects of the needs of soil and water and allow the study of land use transition in urban and rural areas?
- How to favor swift decisions and flexibility in delivering permits for specific uses on land for limited periods (interim use of land) and (if necessary) under specific

servitudes, taking into account the cause-effect relationships between soil degradation and our way of life?

- How to make cost-effective the investments in circular economy, the strategies to reduce (improve the efficiency of) the use of natural resources (re-use, technical innovations)?
- How to assess the relationships between economy and ecosystem?

Characteristics of IRT-6: Indicators for assessing the efficiency of the Soil-Sediment-Water-energy nexus of resources	
Links to identified research gaps	Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
National research topics	Examples. FR 5; SE 1; NL 9
Clustered thematic topics	Demand: CTT-D1, 3, 4, 5, 7 Natural Capital: CTT-NC1, 3, 7 Land Management: CTT-LM, 1, 3, 4 Net Impact CTT-NI 1, 2, 3, 4

IRT-7: Farming systems to maintain soil fertility while meeting demand for agricultural products

Theme proposed by C. Schröter-Schlaack (UFZ)

Background: A growing world population and increasing demand for food and non-food agricultural products puts high pressure on farming systems to intensify production. At the same time, it becomes more and more obvious, that intensifying conventional farming may be accompanied by severe negative environmental consequences, such as reduced bio- and agrobiodiversity, nutrient leaching to groundwater and rivers, eutrophication of lakes and the sea, and in particular loss of fertile soils due to erosion, nutrient loss and soil compaction. There are now several agricultural production techniques being developed that may allow for better maintenance of soil fertility and reducing negative environmental impacts of conventional farming in rural as well as urban and peri-urban contexts. However, it is yet unclear, if these farming techniques could be scaled up to attain the goal of food security and the demand for non-food products. Moreover, it needs to be better understood what role technology development e.g. precision farming might play in reducing environmental externalities of conventional farming systems and increasing return of soil-friendly agricultural practices. Finally, it needs to be revealed what would be necessary in terms of knowledge transfer and reforms of policies and regulations to set incentives for adopting sustainable soil management practices at farm level.

Goal: Understanding how sustainable soil management by appropriate agricultural production systems can contribute to sustainable food security, if and how these solutions can be scaled up and widely implemented on farm level.

So what? Understanding the potential of different agricultural production systems to achieve the goal of food security while sustain soil fertility and reduce negative environmental impacts coming along with intensification of conventional farming would clarify the role of

these different techniques to. This is fundamental to increase knowledge about economic and technical aspects of organic farming, their advantages and disadvantages. It will provide knowledge to improve competitiveness and sustainability and will be useful for farmers and decision-makers in order to mainstream sustainable agricultural practices.

Links to other fields: There are linkages to other potential research topics, such as how to reconcile conflicts between different societal goals (e.g. food security, climate change mitigation, biodiversity conservation, reduced nutrient loads to waterbodies, etc.) or how to spatially optimize (local/regional) land uses (i.e. understanding local soil capacities / thresholds in terms of land use intensity and adapting land use accordingly).

Exemplified research questions

- Identify necessary technology or operation materials to increase the efficiency of agriculture and food security. What can agricultural production systems contribute to reduced environmental impacts (reduction of fertilizer / raised ability of plants to take in nutrients, soil erosion) and how these system solutions can be scaled up?
- How can (efforts and) results of soil quality care be monitored and by the use of which indicators? How could it be used for communication and monitoring (e.g. a threshold value)? What indicators should be used to quantify soil degradation?
- How does biodiversity influence soil fertility, and how does soil fertility influence biodiversity? How to keep soil fertility in climate conditions favorable to high mineralization? What role does soil structure play for soil fertility?
- What are options for resolving conflicts between urbanization and agriculture, e.g. urban farming, small-scale production in urban or peri-urban areas, use of urban organic waste to increase soil carbon on fields?
- How to improve the level of awareness and understanding regarding the environmental benefits of adapted farming systems in agricultural schools and universities and among farmers?
- What are the drivers of decision on production system at farm level? What is the role of policy frameworks (agriculture, climate, housing etc.) and incentives provided to farmers and what are options for the reform of such policies to support implementation of practices to maintain soil fertility?

Characteristics of IRT-7: Farming systems to maintain soil fertility while meeting demand for agricultural products	
Links to identified research gaps	Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
National research topics	AT-1; BE-10; BE-11; BE-23;FR-5; FI-7; DE-5.5; IT-1; PT-2; PT-5; RO-1; RO-2; RO-3; ES-3.8; SW-5; NL-1; NL-11; NL-13
Clustered thematic topics	Demand: CTT-D1, 2, 6, 7 Natural Capital: CTT-NC1, 2, 5 ,7 Land Management: CTT-LM1.1, 1.2, 1.3, 4 Net Impact CTT-NI1.1, 2.2, 3.2, 3.3, 4.1, 4.3

IRT-8: Circular land management

Theme proposed by U. Ferber (StadtLand)

Background: Ongoing urbanisation due to the remaining insufficient level of urban regeneration and persistence of brownfields. Growing and shrinking cities with different land dynamics and development objectives. Demographic change leads to new requirement on urban structures.

Goal: Minimize the consumption of land by continuously renovating settlement structures and overcoming the past's legacy by reusing and redeveloping abandoned, derelict and under-used land. Modernising permanently existing settlement structures by circular land management. exchange and use of existing local, regional and national initiatives and tools at a wider level.

So what? Research is required to understand the patterns of behaviour and interdependencies of actors active in land-related policy areas on a theoretical and practical level. It is important to combine the strategies and instruments by circular land management through applied research and pilot case studies and in the sense of modular “tool boxes” to qualify a sustainable land management. Specific attention should be taken on the interaction with landowners.

Links to other fields: Circular land management is related to all topics linked to Governance, spatial planning and conflict management.

Exemplified research questions

- What drivers are responsible for the consumption of land (for example private investments, city development or investment-oriented assistance programs)?
- How can dynamic scenarios for land use transition be displayed to predict needs and to provide a contribution to the integration into spatial planning?
- Which legal, economic and planning instruments and tools are needed and how could they interact to create positive synergies in relation to the land cycle?
- How do legal and administrative frameworks and governance hinder or enhance the land cycle and how could this frameworks be implemented?
- How could CLM include the population and support conflict management?
- How can stakeholders, especially landowners, be included in circular land management?
- How could planning procedures be reformed in order to enhance the modernization of settlement structures?
- What role plays interim and underused land in the system?
- How can sectoral and spatial assistance programmes be better coordinated with one another?
- What would a monitoring concept which focuses on natural science and the social evaluation and assessment of land use transition look like?

Characteristics of IRT-8: Circular land management		
Links to identified research gaps		Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
	National	AT 5/ 9/10/13, BE 5/6/10/13/18/24/26, CZ 1/2/6, FI 1/4/6/7/ 9/11/13, FR 2/5, DE 2.1/2.3 3.1/3.5/5.1, 5.3, It 2/3, PL 2/3/ 4/6 PT1/2/ 5/6 RO 2, SK4/9, SL 1/5/3, ES 3.1/3.1/4/6/7, SW 2/3/5/6 Ch 2.1 NL 1/3/5/6/8/12/15 UK 2/3/4, IR 1
	Clustered thematic topics	Demand: CTT D3, CTT D7 Natural Capital: - Land Management: CTT-LM 1,3,5,7 Net Impact CTT- NI 1.4

IRT-9: Policies to effectively reduce land consumption for settlement development

Theme proposed by C. Schröter-Schlaack (UFZ)

Background: Land use for settlements is a main driver of loss of fertile soils and agricultural land. Land consumption, however, is itself driven by a range of different motives: changing life-style patterns, demographic change, economic developments (e.g. e-commerce, logistics), infrastructure development, trends in property and financial markets, housing policy, regional planning, building codes as well as agricultural and nature conservation policies. In turn, efforts to promote compact city development, revitalize inner-city brownfields and abandoned sites and reduce consumption of fertile soils for settlements and related infrastructure often fail due to a lack of policies and regulations effectively addressing the drivers of land consumption.

Goal: A better understanding what drives land consumption for settlement development and what constitutes incentives or obstacles for the enforcement of planning and policies to reduce land consumption will help to create policy interventions in property markets and settlement development more effective.

So what? Spatial planning and soil management is often not hampered by a lack of scientific knowledge on the benefits of reduced land consumption for settlement development but by a lack of understanding what actually drives land consumption and how to address these drivers. In turn, existing legislation and planning to steer land development is often failing to address these drivers and moreover characterized by lose implementation and enforcement. Knowledge on how to design effective policies given the institutional constraints of their implementation and enforcement will be necessary to realize the benefits of reduced land consumption in rural and urban areas.

Links to other fields: Steering urban development is but one societal challenge where information about how to design effective policy responses would be beneficial. Other areas include e.g. the implementation of sustainable agriculture, the regulation of pollutants, or incentives to promote the re-use of revitalized brownfields.

Exemplified research questions

- Identify and monitor the drivers of land use that eventually lead to land consumption and urban sprawl: improve understanding of impacts of life-style patterns,

demographics, economic trends, spatial policy, site competition and tax policy, agriculture and nature conservation policies on spatial development. Gain insights on impacts of capital markets on construction, real-estate sector, investment business.

- Is demand for land in different sectors (housing, industry and traffic) driven by different factors?
- Building up a monitoring system to observe the drivers of land consumption and urban sprawl.
- Take stock of different approaches used in different European countries and assess what works and what do not work? What insights can we gain from good examples / best practices as well as from policy failures experienced elsewhere?
- How can the often fractured responsibilities of public power between national state, regions and municipalities be better coordinated or unified to improve sustainable settlement development and reduce land consumption?
- What is the role of "territorial" expert knowledge (land use, soil, water etc.) on policy-making and how can it be used to develop more effective regulations?
- How could 3D-planning (recognizing the different time-scales of impacts on the soil-water-sediment nexus) look like?
- How to solve the trade-off between preserving cultural heritage and addressing challenges for urban development (such as climate change adaptation, energy efficiency, or natural hazards – earthquakes / floods)?

Characteristics of IRT-9: Policies to effectively reduce land consumption for settlement development		
Links to identified research gaps		Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
	National research topics	AT-6; AT-13; BE-2; FI-11; FI-15; FR-1; DE-2.2; DE-5.3; DE-5.4; PL-4; SR-7; SI-1; SI-2; ES-3.1; CH-1.1; CH-1.3; CH-2.12; NL-9; NL-10
	Clustered thematic topics	Demand: CTT-D1, 2, 3, 7 Natural Capital: CTT-NC1, 5, 7 Land Management: CTT-LM1.1, 1.2, 3 Net Impact CTT-NI1.4, 2.4, 2.5, 3.1

IRT-10: Stakeholder participation to facilitate the development of livable cities

Theme proposed by C. Schröter-Schlaack (UFZ)

Background: Urban development and creating livable cities involves of a huge variety of stakeholders, such as private households, business, planning authorities, land developers, conservationists and has to find a transparent and legitimate balance between the different interests of these groups and people. Against this background, stakeholder participation seems a promising approach in order identify mutual benefits but also conflicts between different interests. Participation processes, related infrastructure and tools may also provide a platform for exchange and communication. However, a wide range of open questions has

to be answered to exploit the full potential of participatory processes and to enhance decision-making in terms of legitimacy, acceptance and local ownership.

Goal: Understanding how stakeholder participation may facilitate urban development and the creating of livable urban spaces, what pro and cons different participatory approaches entail in a given context and how it might be best embedded in the course of planning and project development.

So what? Understanding the potential of stakeholder participation will help to ensure the livability of urban development and enhance transparency and legitimacy of decision-making.

Links to other fields: While urban green infrastructure constitutes just an example for the need to recognize and moderate conflicting land use-interests, research regarding the benefits of participation, the design of participatory measures and the pros and cons this might entail would be of great benefit for other conflict situations, too, e.g. in deciding upon land use intensities, designating protected areas, spatially optimizing land use at landscape level and so forth.

Exemplified research questions

- How can methods be designed so that the participation of the public in evaluating land-use options becomes possible? What are best practices and good examples across different countries and fields of application – but also: what can be learned from failures of participatory processes elsewhere?
- How to develop cost-effective participatory tools that also motivate people to participate to ensure inclusive decision making and social empowerment?
- How to take into account long-term consequences of decisions?
- How can knowledge about impacts of land use (change) and land use planning be translated into information for stakeholders taking part in participation processes?
- How to take into account the interest of those not participating?
- What is the relationship between participation and democratic process?
- What is the best time and stage for participation in course of a development project?

Characteristics of IRT-10: Stakeholder participation to facilitate the development of livable cities	
Links to identified research gaps	Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
National research topics	AT-11; BE-6; BE-24; CZ-6; FI-11; FI-15; DE-2.1; DE-6.2; IT-4; PT-5; PT-6; SR-7; SI-1; ES-2; ES-3.14; SW-4; CH-5.1; NL-5;
Clustered thematic topics	Demand: CTT-D2, 3 ,6, 7 Natural Capital: CTT-NC2, 4, 5 ,7 Land Management: CTT-LM1.3, 3 Net Impact CTT-NI3.2, 3.3, 4.1, 4.2, 4.3

IRT-11: Integrated management of soils in urban areas

Theme proposed by J.Gorgoń & A.Starzewska-Sikorska (IETU)

Background: Urban development has been defined by expansion of urban structures into surrounding rural areas, cropland and forests. Urban soils are created by the process of urbanization, therefore cannot be separated from its geographic bounds. Urban activities could create different types of new man-made soils, but all soils situated within cities or urbanized areas should be included to category of urban soils. Due to a multi-functional role of the soil in urban areas the sound management of this resource is of a key importance in urban land management. Typology of urban soils is important to perceive these soils through the wide perspective including diversity of soil functions. It is also important to define the suitability of soils for different urban land uses. Soil characteristics and quality should be take into consideration by spatial (urban) planning. From the perspective of ecosystem services and SSW system, urban soils are important part of green infrastructure. Especially soil of a high quality should be protected to maintain the habitat and support ecosystem services potential. Also agricultural role of soil in urban areas should not be neglected, especially in the context of urban farming and gardening, as well as from the perspective of the global food production market.

Goal: Better understanding the role of urban soils and their importance on improving quality of urban space and consequently on health and living quality.

So what? In order to steer better use of urban soils in a sustainable way, a proper management of soil resources is needed. The soil management systems that efficiently protect the best soils should be introduced in cities. There is also need of reuse and improving of urban soil quality by innovative remediation technologies. A multidisciplinary approach is necessary for better understanding of the soil role in urban environment in order to ensure its optimum use and provide the functions needed, like water filtering and storage, space for fauna and flora, provision of recreation areas etc. Human health is also important in the context of urban soils management, and should be take into account in urban planning and land management.

Links to other fields: Next to urban soils, also water and sediments in urban areas are important in the context of ecosystem service research.

Exemplified research questions

- Do we understand the role of urban soil and its different function in the urban areas?
- How to secure safety and health in the context of contaminated soil management? How to deal with urban soil pollution? How to introduce temporary use of contaminated soils in land management?
- What are the possibilities for re-cultivation of abandoned land and what are the benefits for sustainable land management?
- How to take into account various types of urban soils in spatial planning?
- How to introduce into spatial (urban) planning soil quality management aspects?
- How to integrate soil management with climate change aspects?
- How to conserve the fertility of soil in the long term?

- How can we develop a policy to prevent soil sealing? How can we integrate these policies in spatial planning processes? ? How to reduce the pressure on land?
- How do different land use policies, such as agricultural policy and city planning policy, contribute to the environmental impacts of land use?
- Approaches, methods and instruments of the productive land protection against its transformation towards build-up areas.
- How to deal with private land ownership in relation to urban soil protection?

Characteristics of IRT-11: Integrated management of soils in urban areas		
Links to identified research gaps		Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
	National research topics	AT 7, 8; BE 11, 12, 16, 21, 28; FI 1, 4, 11; FR 1, 3; DE 4.1; NL 5, 7, 13; PL 3, 4
	Clustered thematic topics	Demand: CTT-D1, 2, 3, 4 Natural Capital: CTT-NC1, 2, 3, 5, 7 Land Management: CTT-LM1.1, 1.3, 1.4, 3, 4 Net Impact CTT-NI1.1, 1.2, 1.3, 1.6, 2.1, 2.2, 3.2, 3.3, 4.1, 4.3

IRT-12: Environmentally friendly and socially sensitive urban development

Theme proposed by S. Schubert & S. Bartke (UBA)

Background: Urban development is confronted with heterogeneous and often conflicting needs. Concerns of urban environmental protection and precautions are strongly interconnected with urban development and have to be considered in planning and decision making processes in manifold ways. However, they are just one concern out of many and have to be balanced with other challenges of urban development, not least with social concerns. The latter reflects for instance the needs for affordable housing and security of energy and water supply. On the one hand, social and environmental needs can have synergies and the concept of environmental justice is an upcoming but central interface. On the other hand, conflicting goals of an environmentally friendly and at the same time socially sensitive urban development can be detected, as for example in the field of energy poverty (greener but more expensive renewable energy puts some households at poverty risk). Moreover, complexity is added as also in different cities different societal groups will not have the same interests and, hence, social contexts differ nationally and across Europe.

Goal: Better understand potential synergies and trade-offs of environmental and social concerns in urban development. Identify and more clearly describe conflicting goals and measures with sufficient indicators and find solutions to reduce and dissolve them.

So what? Urban development is stressed by environmental and social framing conditions. Solutions to bridge the goals of urban environmental protection and social concerns of urban development are crucial to realize sustainable cities. Knowledge on environmental issues in urban planning as well as on social concerns is partly available but has to be better integrated and new questions arise at the interface of both dimension, especially addressing implementation and daily practice of urban planning.

Links to other fields: Research in this field is linked to understanding trade-offs and synergies in the different dimensions of sustainable development more generally. Insights might also be relevant for other (than urban) areas of natural resources protection.

Exemplified research questions

- What are the main conflicts of goals between environmental and social concerns which have to be addressed in district development? Can the ecosystem services approach link the dimensions?
- How to better understand and then steer behavior? What are drivers (markets and economy, regulation [local, EC], awareness of ecosystem services in cities, ecology)? How can the individual demands of different individuals in an area be met and still be environmentally friendly?
- What are facilitators for awareness of environmental and social dimensions equally (urban agriculture/gardening, climate/weather extremes, education)? What are drivers and inhibitors of behavioural change?
- How to efficiently integrate citizens in social and environmental decisions on urban development? How to enable more efficient stakeholder (e.g. NGO) engagement?
- How can environmental and social concerns be strengthened in planning processes of formal and informal instruments of urban planning? How can the interplay of environmental, health and social concerns in planning and decision making on the local level be better integrated to reach more environmental justice and social cohesion?
- How to balance strict environmental protection without limiting societal discourse on desired urban development? (Is environmental protection regulation to strict? Can strategic environmental assessment be improved?)
- Which financing mechanism on the municipal, state or national level bear barriers for the implementation of environmental and social measures in urban development and how can they be overcome? Can participatory budgets align citizens with environmental goals better? How can regulation and taxation reflecting an ecosystem approach be implemented?
- Which settlement and building structures allow a land-saving, dense and lively but to the same time healthy and quiet urban living conditions? What is the maximum density that is still regarded as high-quality of living? How to add more green and living area to a given urban setting?
- What is the link of milieus and environment? Have rich and poor the same access to urban green? Are rich locating in silent healthy areas and poor on brownfields? How to address social inequalities?
- How to better implement the available expertise on how to better design building and settlement structures which are energy efficient, supplied by renewable energies, allow decentralized rain- and greywater management and are still affordable for all?
- Can a systemic database be provided with best- and worst-practice examples of environmental and social conclusive urban development measures/approaches?

Characteristics of IRT-12: Environmentally friendly and socially sensitive urban development		
Links to identified research gaps		Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
	National research topics	AT 5, 10, 11, 14; BE 6, 9, 13, 22, 24, 26, 27; CZ 1, 6, 8; FI 3, 11, 14, 15; FR 5; DE 1.1, 2.1, 2.2, 2.5, 3.4, 6.1, 6.2, 6.3; IT 3, 4; PL 1, 3, 4; PT 5, 6; SR 2; SI 1, 4; ES 2, 3.9, 3.13; SE 2, 4, 7, 9; CH 1.2, 2.1, 2.3, 2.11, 2.12, 5.1; NL 5, 8, 10; UK 6
	Clustered thematic topics	Demand: CTT-D2, 3, 6, 7 Natural Capital: CTT-NC1, 7 Land Management: CTT-LM 1.2, 1.3, 3 Net Impact CTT-NI 1.1, 1.3, 1.5, 1.6, 2.2, 2.4, 3.1, 3.3, 4.2

IRT-13: Urban Metabolism – Enhance efficient use of soil-sediment-water resources through a closing of urban material loops

Theme proposed by D. Reißmann, S. Bartke (UBA)

Background: Provision, use and consumption of resources are usually considered merely with regard to specific products or services. However, a systemic understanding is needed for sustainable development – not least in the case of resources of the soil-sediment-water system. The concept of urban metabolism tries to integrate all urban material flows, stocks, loops and their internal and external interdependencies in a comprehensive way.

Urban metabolism – according to urbanmetabilism.org – is the study of material and energy flows arising from urban socioeconomic activities and regional and global biogeochemical processes. The characterization of these flows and the relationships between anthropogenic urban activities and natural processes and cycles defines the behavior of urban production and consumption. Urban metabolism is therefore a deeply multi-disciplinary research domain focused on providing important insights into the behavior of cities for the purpose of advancing effective proposals for a more humane and ecologically responsible future.

Goal: Through a comprehensive understanding of urban material flows, stocks and loops and their environmental impacts the concept aims to develop practically useful strategies, tools and instruments to enhance urban resource efficiency, consistency and sufficiency and to minimize direct and indirect negative environmental impacts that are initiated by urban areas.

So what? Without further development of the methodological concept of urban metabolism, it will be not possible to identify comprehensive measures enhancing urban resource efficiency, consistency and sufficiency. This is the to develop instruments and tools for actors on different scales (local, regional, national and supranational) which foster resource friendly urban areas based on the above mentioned principles of efficiency, consistency and sufficiency. The developed tools need to address indirect impacts, such as rebound effects or indirect land consumption. Further research in this issue is crucial for a sustainable development, because through these instruments and tools it becomes possible to save our common resource basis, minimize negative ecological effects, foster the local economy through an urban circular economy and guarantee a high level of urban quality of life also into the future.

Links to other fields: The urban metabolism links to a variety of different fields, e.g. resource efficiency, construction, urban planning, infrastructure design and more.

Exemplified research questions

- What are the negative externalities (emissions, land consumption, pollution load etc.) of currently dominating construction materials from soil in cities and how can the usage of regional and/or renewable materials improve the picture? What measures identify "hidden flows" in urban processes, products and services? If new materials are to replace old ones, what are the side effects?
- Can the concept of "land footprint" inform decision making? Which indicators are easy to be understood by citizens to increase awareness of resource use impacts? How to raise awareness in the public for the land and soil-sediment-water impacts of urban resource consumption and storage?
- What are/is the optimal scale/s that ensure/s an efficient and controllable urban circular economy (building, district, city, region … - and for which type of resource / material)? Which are suitable indicators for assessment and monitoring? What is the optimal size of the city to enable most efficient metabolism?
- What are the main driving forces for urban resource and material flows and which stakeholder group could influence these driving forces directly or indirectly? Who should bear and who bears responsibilities? Are new rules needed to steer sustainable flows or what can be efficient means to better management?
- Which and how many resources have been accumulated in cities (what are today's stocks)? Which urban materials are suitable for recycling (urban mining)? Is it possible to "produce" suitability through conditioning of materials?
- What are the theoretical and practical potentials or urban and landfill mining under scenarios of different market resource prices? What is the impact of material markets and competition and how to trade off different material demands sustainably?
- What are socio-economic, cultural and legal barriers for an integrated urban metabolism management? Which agents are crucial to enable the concepts implementation? Which governance and policy is needed? How to raise acceptance for recycled products? How can proper spatial planning reduce raw material needs in the city?
- How safe is the handling of materials? Which materials are safe to use?
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Characteristics of IRT-13: Urban Metabolism – Enhance resource efficiency through a closing of urban material loops		
Links to identified research gaps		Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
	National research topics	AT 5, 7; BE 5, 6, 9, 13, 24, 26; CZ 1, 2, 4; FI 5, 9, 11, 13; FR 1; DE 2.3, 2.5, 4.2; IT 3; PL 3, 4; PT 2, 3, 5; RO 3; SR 3, 7; SI 2; ES 3.1, 3.3, 3.4, 3.6, 3.8, 3.9; SE 3, 4, 7; NL 5, 6, 7, 8, 9; UK 3, 5; IR 1
	Clustered thematic topics	Demand: CTT-D3, 4, 5, 7 Natural Capital: CTT-NC1, 3, 6 Land Management: CTT-LM1.4, 3 Net Impact CTT-NI1.1, 1.2, 1.6, 2.3, 3.

IRT-14: 'Emerging contaminants' in soil and groundwater – ensuring long-term provision of drinking water as well as soil and freshwater ecosystem services

Theme proposed by C. Schröter-Schlaack (UFZ) and Frank Glante (UBA)

Background: Deteriorating groundwater quality and reduced soil ecosystem services are serious issues in various European countries. Immission of 'emerging contaminants', e.g. pesticides used in agriculture, chemical substances used in industrial production or from waste and sewage may worsen the problem. However, by now it is often unclear what are the impacts of these substances on different temporal and spatial scales, how impacts may be altered by mixing of those contaminants and what are cost-effective strategies to minimize their discharge or to remediate contamination.

Goal: Better understand the impacts of 'emerging contaminants' to develop cost-effective management opportunities for safeguarding freshwater and soil related ecosystem services

So what? The lack of knowledge about 'emerging' and mixed contaminants properties, their distribution in the different environmental matrices, in particular in groundwater and soils, the interaction of those contaminants with human health as well as soil and freshwater related ecosystem services has to be filled in order to avoid risks for public health and to ensure long-term provision of ecosystem services. Definition of what are emerging contaminants are needed as well as methods of analyzing and assessing. Therefore threshold values for these contaminants have to elaborate (methods, pathways, food-chain, and human health) for substances but also for mixtures. Environment specimen banks can provide samples retrospective to analyze if and when an emerging substance was found first in the environment (www.umweltprobenbank.de). More samples (media) than existing are needed.

Links to other fields: Next to pollution of groundwater, also soils and sediments are of importance to understand the impact of (mixed) 'emerging contaminants' on human health and soil and freshwater ecosystem services and may be subject to specific research efforts.

Exemplified research questions

- Which (emerging) contaminants remain a (potential) risk to health (drinking water) or ecosystems?
- Need to research on how to consider emerging contaminants into risk assessment models and to develop threshold values for emerging contaminants. How could we learn from dealing with "classical" contaminants?
- Need to define harmonized methods for sampling and analyses of such contaminants in soils, sediment and water.
- Could the polluters pays principle can adapted to a producer pays principle (legal research needed)?
- What is the role of soil in the spread and risk of (emerging) contaminants such as medicines and nanoparticles?
- How do contaminants (such as PFAS, fertilizers, and pharmaceuticals) affect raw water quality, treatment processes and mixture toxicity and human health?
- What entails the presence of substances alien to the system for the quality and resilience (biological control) and other qualities and functions of the soil-sediment-water system?

- What techniques, examples and BAT we already have to give solution in acting with emerging contaminants?
- What are the effects from diffuse contaminant sources or sum of contribution from many ”small” sources, from contaminant mixtures and what is the impact of contaminant sinks (such as sediments, fibre banks etc.) on ecosystem services
- How do soil, sediment and water and the substances inside interact (soil-sediment-water system)? What is the potential of the soil and subsurface to provide natural attenuation of contaminants and how can this potential be deployed?
- Which effects of soil biota and in the food chain do we find?
- How could we avoid emerging substances in our economy?
- Do we have solutions against spreading the contaminants due to recycling, reuse?

Characteristics of IRT-14: ‘Emerging contaminants’ in soil and groundwater – ensuring long-term provision of drinking water as well as soil and freshwater ecosystem services	
Links to identified research gaps	Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
National research topics	BE-2; BE-4; IT-2; SW-2; SW-7; CH-3.3; CH-4.2, NL-2; NL-7
Clustered thematic topics	Demand: CTT-D2, 4, 7 Natural Capital: CTT-NC1, 3, 4 Land Management: CTT-LM1.1, 1.2, 3, 4 Net Impact CTT-NI1.1, 1.2, 1.3, 1.5, 2.3, 3.2, 4.1

IRT-15: Sustainable management to ensure the ecological and socio-economic values of degraded land

Theme proposed by F. Makeschin (DIU)

Background: Long-term exhaustive industrial and land use activities affected natural, agricultural and forest land by mining (e.g. peat, lignite), contamination, salinization or erosion in vast areas in Europe and left degraded and often abandoned land. Available information suggests strong evidence that these processes will further increase if no action is taken. Furthermore, the potential for the further degradation of land and the multiple services it provides will continue. Affected land in the EU-25 is estimated to about 3,5 million contaminated sites and soils to about 15% of surface area, both varying highly in its nature and consequent impacts. Exclusive for soil degradation the costs for erosion, organic matter decline, salinization, landslides and contamination would be up to €38 billion annually for EU25. As a consequence, soil and landscape functions are harmfully reduced or sites and landscapes even destroyed, and surface and ground water contaminated. The knowledge about dimensions and especially the grade of degradation is still low, hindering an ecological sound and an economically viable reclamation of these sites and water bodies in a landscape context towards bringing back to ecological functions for alternative adapted land use forms. The direct impacts of degradation are a major cause for concern; however, the indirect consequences and the loss of services potentially have greater implications for society.

Goal: Develop suitable restoration and rehabilitation approaches along the SSW approach to ensure the ecological and socio-economic values of degraded land appropriate to site conditions and type and intensity of degradation

So what? Land is a vital resource enabling the production of food, the preservation of biodiversity, and facilitating the natural management of water systems and acting as a carbon store. Appropriate management can protect and maximize the services land provides to society. The degradation of land is, however, common in Europe and a consequence of physical, chemical and biological shifts driven by environmental, social and economic pressures. Land degradation is the consequence of multiple processes that both directly and indirectly reduce the utility of land. Due to the high extend of degraded land and areas, reversing degradation into functionally valuable land is indispensable. The concrete goals for restoration or rehabilitation have to be specified according to the type and intensity of degradation on the one hand, and the specific target conditions on the other; just using general ecological value targets used for un-degraded land is inadequate. Thus linking classification of degradation together with future targets for future alternatives (soils, ecosystem functions, water resources, biomass production) are necessary reaching assessment to planning and realization. The application of organic residues with very low contaminant level (e.g. urban composts, residues from food industry, treated grey water) as part of restoration has to be investigated. Here learning from good practices for resetting degraded land into ecological functions (historical experiences) is a prerequisite for future innovative management and spatial planning. The legal framework and private ownership will significantly determine the options and realization for re-grading land; thus considering socio-economic and legal conditions will play a crucial for restoration or rehabilitation. Therefore dedicated research is needed to elaborate degradation-type and region-specific restoration and rehabilitation approaches for valorization of degraded areas.

Exemplified research questions

- How to advance the recycling of limited mineral and nutrient resources (e.g. through capturing phosphorous from wastewater or landfill mining)?
- How can the consideration of soil quality for infrastructure projects be improved?
- Define and design sustainable land management approaches to maintain soil fertility and alternatives for soil regeneration, applying some in pilot projects.
- Define alternative technologies and practices for soil and water remediation and to minimize pollution, accounting the various sources of elements, and assessing the costs associated.
- How can funds or incentives for re-cultivation support sustainable land use?
- How big is the potential to grow “usable and sustainable” energy crops on contaminated land?
- How optimized soil functions could support societal demands in urban areas?
- How can sealed areas be re-cultivated to fulfill soil functions and improve land sparing elsewhere?
- How control and improve water quality in contaminated land management from both diffuse and point sources, including emergent contaminant classes?
- Research on technical, structural and innovative solutions, instruments and policies for redevelopment and urban requalification.

- Approaches of rehabilitation for degraded soil systems (heavy metals, pesticides, salted soils etc.)
- Creating awareness with the public on the value of sustainable management of degraded land

Characteristics of IRT-15: Sustainable management and valorization of degraded land		
Links to identified research gaps		Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
	National research topics	AT-4; AT-5; AT-6; AT-7; AT-10; BE-2; BE-5; BE-6; BE-8; BE-9; BE-19; CZ-1; CZ-2; CZ-5; CZ-6; CZ-8; FI-4; FI-9;FI-10; FR-1; FR-5; DE-2,2; DE-7; IT-2; PL-3; PL-6; PT-1; PT-3; PT-6; SR-9; SW-7; UK-2; UK-3
	Clustered thematic topics	Demand: CTT-D1, 2, 3, 4, 5 Natural Capital: CTT-NC2, 3, 4, 5, 7 Land Management: CTT-LM1.2, 1.3, 1.4, 3, 4 Net Impact CTT-NI1.1, 1.3, 1.5

IRT-16: Innovative technologies and eco-engineering 4.0: Challenges for a sustainable use of agricultural, forest and urban landscapes and the SSW system

Theme proposed by F. Makeschin (DIU)

Background: Increasing societal demand on land resources and biomass cause land use pressure and endanger ecosystem functions and sustainability of land, water and bio-resources. Classical technologies focus preliminarily on conventional sectors like agricultural mechanization or landscape engineering. Innovative Key Enabling Technologies KET and eco-engineering as basis for integrated solutions may facilitate a greener economy at larger scale for farmers, forest managers and rehabilitation-related SME to support a future development contributing to a sustainable land management. However, the societal acceptance for KET is restricted. Thus undertstanding and raising awareness for modern sustainable technologies is also a key challenge.

Goal: Develop land use and region-specific manageable, economically viable and sociologically sound technologies and eco-engineering for agricultural, forest and urban areas contributing to a productive and safe environment

So what? Modern rural and urban land use without sound and appropriate sustainable technologies, comprehensive data availability, and purposeful communication is no longer imaginable today. Eco-engineering deals with the design, monitoring and management of both rural and urban ecosystems and can integrate human society into the natural and man-made environment. Future innovative technologies and eco-engineering must consider the regional societal demands and socio-economic conditions. The need for reaching a sustainable intensification via conventional- or organic agriculture and forestry, a region- and site-specific reclamation and rehabilitation of degraded or stressed landscapes is high serving to assess and manage also smaller farm or economical structures. Research demand exists for agricultural- and forest land management (e.g. soil cultivation, planting and plant protection, harvest), for a efficient and clean re-use of nutrients and water (e.g. composts, grey water), for storm water management, for reclamation of brownfields and

heavily degraded areas (erosion, landslides), for high-quality on- and off-site sensor techniques, and for communication technologies to reach distinct target groups inside (farmers) and outside (civil society). Sound innovative technologies may support biological conservation or re-habilitation of heavily degraded landscapes. Focus should be given also to modern, target-group specific information technologies for raising a science-based knowledge and awareness. And finally, industry strongly needs planning security in order to invest in goal-oriented new technologies targeting the Sustainable Development Goals.

Links to other fields: Technologies in their broader context gain increased importance not only for the conventional management of rural and urban resources, but also for an appropriate, target-group specific knowledge transfer and participation.

Exemplified research questions:

- How can new technologies and advanced digitalisation (in terms of databases, communication) help farmers and foresters to adapt to climate change?
- How to improve the development and use of technologies by business models, private-public partnerships, policies and legislation?
- Which modern technologies for environmental control may serve for a better actual status and future risk prediction (on-site / remote)?
- How to optimize existing and innovative remediation technology for contaminated soil, groundwater, sediment (e.g. for big urban VOC-plumes, e.g. for low permeable geology, e.g. cleaning soil contaminated with multiple parameters)?
- Which technologies may contribute to a better de-contamination and recycling of organic wastes and industrial residues?
- Which appropriate on-site and off-site technologies may improve the monitoring and remediation?
- What are the social- and environmental impacts of new technologies?
- What kind of knowledge is needed to stimulate the reactivation of brownfields?
- Development and use of high tech monitoring and data collection in relation to soil and land use: e.g. real time monitoring using satellites, precision farming, remote sensing and (geo-tele)detection, use of drones.
- How to ensure that the best available technology is used and lifecycle sustainability is taken into account reuse/recycling of excavated contaminated soil materials?
- Set up monitoring devices of soil conditions, the balance genesis vs erosion, the carbon content and carbon stock and the GHG emissions using instrumentation at different scales.
- How can new media and technology, for example social media with a “soil function app”, be used to engage with the broader public?
- What developments in technology are required in agriculture? E.g. remote sensing by satellite, plant disease pattern recognition by drones?
- Development of practical tools able to respond to risks induced by soil degradation processes under the global climate change impact.

Characteristics of IRT-16: Innovative technologies and eco-engineering 4.0	
Links to identified research gaps	Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
National research topics	AT-3; AT-7; BE-5; BE-8; BE-19; BE -25; FI-6; FI-9; DE-4.1; DE-8.2; IT-1; PL-1; PL-6; PT-2; PT-3; ES-3.6; ES-4; SW-4; SW-6; CH-2,.10; NL-14
Clustered thematic topics	Demand: CTT-D3, 5, 6 Natural Capital: CTT-NC3, 4, 5, 6 Land Management: CTT-LM2, 3, 4 Net Impact CTT-NI1, 2

IRT-17: Climate change challenges - improving preparedness and response for climate conditions and related hazards

Theme proposed by J. Gorgoń (IETU)

Background: Climate change is seen to be a very complex and challenging issue, which refers to the urban and rural areas management at all scales from global to the local. It has been mentioned in almost all national reports as very important and affecting every topic concerned issue. This theme is also coherent with the EU Strategy on adaptation to climate change(adopted by the European Commission in April 2013), which sets out a framework and mechanisms for taking the EU's preparedness for current and future climate impacts. Also COP21 results and guidelines should be take into consideration, especially those related to carbon sequestration in soils, because fertile soils are able to cope with the effects of climate changes. Important for planning systems and land management practices is taking into account IPCC scenarios with regards to various level of legal responsibilities (national, regional and local). Time frame for all activities related to climate change mitigation and adaptation should be precise (including short, medium and long- term actions).

Goal: To introduce or strengthen climate change aspects into spatial planning and land management practice, and to reinforce administrative, technical and societal preparedness for climate extremes and related hazards.

So what? Climate change affects all European countries. Impacts and vulnerabilities for nature, the economy and society differ across regions, territories and economic sectors in Europe. Challenges of climate change require two types of responses. First is related to climate change mitigation, second is adaptation activities to deal with the unavoidable impacts. Spatial planning could be an instrument for coping with effects of climate change, but it requires better understanding of its role in the process of climate change mitigation, adaptation and counteracting negative climate phenomena. Integrated strategies on climate change mitigation and adaptation referring to soil protection and land management should answer questions: how to reduce direct and indirect impacts from climate change. Land management could play an important role in coping with climate change impacts by introducing new innovative technical and operational solutions, as well by including broad scope of stakeholders into this process. Both, spatial planning and land management could improve climate change resilience, but it need to reinforce co-ordination between them.

Links to other fields: Climate change challenge is related to all topics linked to the soil and land protection and management, however there is need to strengthen research efforts and interrelate to economy and social sciences.

Exemplified research questions

- How to adapt to climate change by an appropriate spatial (urban and rural) land planning and management? How can land management influence climate change mitigation? How to formulate criteria on mitigation and adaptation for its integration with spatial planning?
- How to distinguished and monitor climate change impact on different areas -urban and rural? Need for key indicators defined by appropriate criteria.
- How to address climate change policy questions, respecting different level of responsibility? How to integrate the decision making process with different levels?
- How to implement tools and instruments concerning vulnerability into spatial planning? How to improve resilience of urban and rural areas?
- How to design technologies and planning tools for climate change adaptation of resource efficient wastewater systems for a sustainable built environment?
- How to improve resilience, adaptation capacity through land use planning by paying attention to flood management and other ecosystem-based ways of adaptation? How to take advantage of ecosystem services in climate change policy (in urban and rural areas)?
- What can land use and management of the soil-sediment-water system contribute to tackling challenges related to climate change?
- What are the costs and benefits of climate adaptation and mitigation policy for the soil-sediment-water system?
- What methodological approach is required for concepts of climate change adaption? Need for integration : spatial planning, civil engineering, water management, etc.
- How to improve social responsibility and awareness on climate change issues?
- What can we do now to adapt for climate change?

Characteristics of IRT-17: Climate change challenges - improving preparedness and response for climate conditions and related hazards		
Links to identified research gaps		Indicated are numbers of relevant research topics from National Reports (cf. D2.5, Brils et al. 2016) AND for the relevant Clustered Thematic Topics (as defined above):
	National	AT-4; AT-10; CZ-4 ;FI-4; FI-7; FI-12; FI-16; FR-2; DE-2.5; DE-7; PL-1 PT-4; PT-5; PT-10;RO-1;SR-4; SR-8; SI-2; ES-3.11; ES-3.12; SW-1;SW-4;CH-2.8; CH-3.3; NL-3; NL-5;
	Clustered thematic topics	Demand: CTT-D2, 3, 4, 5, 7 Natural Capital: CTT-NC1, 2, 3, 5, 7 Land Management: CTT-LM1.1, 1.2, 1.3, 1.4, 2, 3, 4 Net Impact CTT-NI1.1, 1.2, 1.3, 1.5, 2, 3.2, 4.1

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